

Bryophytes of the Cerrado: a floristic study in an urban area and in two conservation units in eastern Maranhão, Brazil

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Abstract. Bryophyte studies in the Cerrado Maranhense over the last five years have revealed 42 newly recorded species of bryophytes. Although the highest concentration of studies have been undertaken in eastern Maranhão, there are still areas there that have not been inventoried, such as the conservation units in the municipality of Chapadinha. Herein, we inventory the bryophytes in this municipality. Data were obtained from bryophyte specimens deposited in the herbarium Centro de Ciências Agrárias e Ambientais, Universidade Federal do Maranhão and additional material collected by us. We identified 303 specimens representing 54 species, which included two hornworts, 25 liverworts, and 27 mosses. Two species are newly reported from the state: *Plagiochila subplana* Lindenb. and *Fissidens subulatus* Mitt.; the distribution of the latter species is extended into the Brazilian Cerrado. Our study shows the importance of increasing sampling efforts for bryophytes in Maranhão and highlights the diversity of these Cerrado formations.

Key words. Diversity, hornworts, inventory, liverworts, mosses

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INTRODUCTION

Bryophytes are nonvascular plants derived from a single ancestor and divided into three monophyletic lineages: hornworts, liverworts, and mosses (Puttick et al. 2018; Harris et al. 2020). There are approximately 18,000 species worldwide, with about 150 species of hornworts, 13,000 species of mosses, and 5,000 species of liverworts. Bryophytes prefer moist, shaded environments, such as tropical forests, but they also occur in xeric and very cold environments (Goffinet et al. 2009). Of the 1,618 species of bryophyte known in Brazil, the Cerrado has 510 (Flora e Funga do Brasil 2024).

The first species records for the state of Maranhão came from floras, species lists, and taxonomic revisions (e.g. Yano et al. 1987, 2009; Yano 1992, 2004; Gradstein 1994; Pursell 2007). According to the *Flora e Funga do Brasil* (2024), the known diversity of bryophytes in the state includes 93 species, 53 genera, and 28 families, of which 82 species, 47 genera, and 27 families occur in the Maranhão Cerrado.

In the last 15 years, studies on the bryophyte flora of the state have increased in number and have added species recorded in the Maranhão Cerrado, bringing the total to 274 (Brito et al. 2009; Conceição et al. 2010; Santos and Conceição 2010; Varão et al. 2011; Peralta et al. 2011; Costa et al. 2015, 2018, 2021; Vieira et al. 2017; Oliveira et al. 2018a, 2018d, 2020; Silva et al. 2018a, 2018b, 2021; Fernandes et al. 2021b). Almost half of these studies were conducted in conservation units: the Environmental Protection Areas of Inhamum and Buriti do Meio, both located in the city of Caxias; Parque Estadual do Mirador; and Parque Nacional da Chapada das Mesas; these conservation units show a higher species diversity than areas outside of these areas, with 232 species (Brito et al. 2009; Santos and Conceição 2010; Costa et al. 2015, 2018, 2021; Oliveira et al. 2018c, 2020; Silva et al. 2018a, 2021; Fernandes et al. 2021b).

With 11 studies on the bryophytes of the Cerrado of eastern Maranhão, this region has higher concentration of studies than other regions of the state; however, nine studies were conducted only in the municipality of Caxias, in urban fragments and conservation units, which recorded 116 species, of which 27 were newly reported from the state and five were new for the Northeast Region of Brazil (Brito et al. 2009; Conceição et al. 2010;



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Costa et al. 2015, 2018; Oliveira et al. 2018a, 2018b, 2018c; Silva et al. 2018a; Bonfim et al. 2019). Two additional studies were done in eastern Maranhão, one in the city of São João do Sóter, where Vieira et al. (2017) added three more species to the Maranhão bryophyte list, and the other by in the cities of Anapurus and Chapadinha, where Silva et al. (2018b) sampled the genus *Riccia* L. and added two more bryophyte species.

There is a noticeable concentration of bryophyte sampling in eastern Maranhão. However, there are conservation units there that have not yet been studied, such as Reserva Extrativista (Resex) Chapada Limpa and Área de Relevante Interesse Ecológico Itamacaoca (ARIE) Itamacaoca, both in the municipality of Chapadinha.

Our aim was to inventory the bryophyte species in the municipality of Chapadinha. A list of species is provided, along with data on geographic distribution and comments on the species found. Our study will support future ecological, conservation, and management efforts of the studied conservation units and, thus, contribute to the protection of the Brazilian Cerrado.

STUDY AREA

The municipality of Chapadinha, Maranhão (Figure 1), located in eastern Maranhão in Lower Parnaíba micro-region, covers an area of slightly over 3,200 km² (IBGE 1992, 2019).

the predominant environment in the municipality is the Cerrado, with areas (including well-preserved fragments) of gallery forest, campo cerrado, and cerradão interspersed with springs and streams (Silva et al. 2008, 2016). the months with the greatest and least rainfall in this area are March (384.2 mm) and September (4.0 mm), respectively (Novais 2016). The average annual temperature is 27.9 °C, with little thermal amplitude; the monthly average minimum temperature is 26.9 °C in June, and the maximum is 29.3 °C in October and November (Passos et al. 2016). Climatic conditions vary across the state, and the semi-humid climate covers a significant part of the territory of Maranhão (Silva et al. 2016; NuGeo/UEMA 2016).

The geology of this municipality consists of fine, clayey sandstones and ferruginous *canga* vegetation from the Itapecuru Formation of the Upper Cretaceous, as well as fluvial colluvial sands from the Alluvial and Colluvial Deposits of the Cenozoic–Quaternary–Holocene. The municipality is geomorphologically located

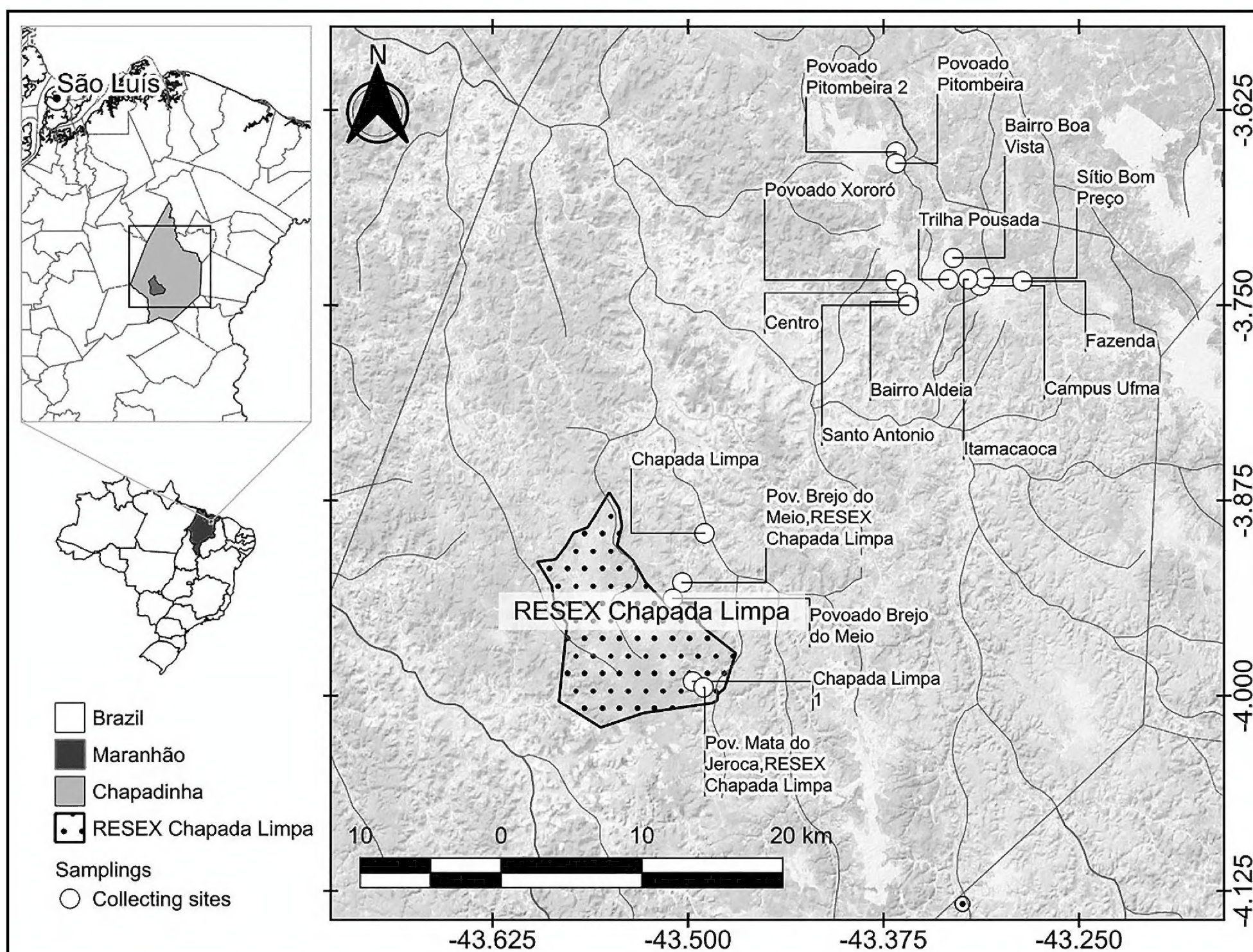


Figure 1. Map indicating collection sites in the municipality of Chapadinha, Maranhão, Brazil.

in the Chapadinha Tablelands, which is also called Sublittoral Tablelands (IBGE 2011a) and positioned on the western limit of the tablelands. This vast area consists of low (80–120 m) undissected plateaus where very deep soils (>2.0 m) develop. The soils are well drained and have low natural fertility, with dystrophic Yellow Latosols predominating on the plains at the tops of the low plateaus, and, in the slightly dissected areas, argisolic concretionary Plinthosols and petroplintic dystrophic Red-Yellow Argisols (IBGE 2011b).

Chapadinha has two protected areas: ARIE Itamacaoca and Reserva Extrativista Chapada Limpa (Resex Chapada Limpa). Both are classified as sustainable-use units, based on the specific characteristics of each area. In addition, the municipality has permanent protected areas that conserve springs and associated bodies of water, such as in the neighborhoods of Aldeia, Angelim, and Repouso do Guerreiro (Silva et al. 2008; Barbosa et al. 2020; ISA 2024).

METHODS

We based our study on bryophyte samples deposited in the herbarium at Centro de Ciências Agrárias e Ambientais, Universidade Federal do Maranhão (CCAA). These samples were collected in the municipality of Chapadinha between 2015 and 2020. We made additional collections from gallery forests in ARIE Itamacaoca and Resex Chapada Limpa, as well as in the neighborhoods of Aldeia, Angelim, Repouso do Guerreiro, Boa Vista, Corrente, and the city center. Our additional collections were made during free-walking surveys (Filgueiras et al. 1994), mainly during the rainy season from November to May in 2017 and 2020. We followed the methods of Glime (2017b) for the collection, preservation, and herborization of specimens. Our collected specimens were deposited in the CCAA herbarium, and duplicates of some specimens were sent to the MG, HBRA, and RB herbaria (herbarium acronyms follow Thiers 2022).

The taxonomic classification of Anthocerotophyta are based on Renzaglia et al. (2009), while the classification of Marchantiophyta and Bryophyta follow Crandall-Stotler et al. (2009) and Goffinet et al. (2009), respectively, with adaptations from Carvalho-Silva et al. (2017) for *Sematophyllaceae* Broth., Shi and Zhu (2015) for *Dibrachiella* (Spruce) X.Q. Shi, R.L.Zhu & Gradst., and Sukkharak and Gradstein (2017) for *Thysananthus* Lindenb. Classification of lifeforms is based on the studies by Magdefrau (1982) and Richards (1984). Nomenclature and authorship of species are from the International Plant Names Index (IPNI 2020) and the Tropicos v. 3.3.2 website (Tropicos.org 2024). The classification of species according to substrate type followed Robbins (1952) and Gradstein et al. (2001).

Species identification was based on the literature (Reiner-Drehwald 2000; Buck 2003; Gradstein and Costa 2003; Dauphin 2008; Bastos and Yano 2009; Gradstein and Ilkiu-Borges 2009; Gradstein 2021). The geographic distribution of the species is based on the studies by Gradstein and Costa (2003), Costa and Peralta (2015), and Flora e Funga do Brasil (2024). Botanical terminology for bryophytes followed the glossary by Luizi-Ponzo et al. (2006).

Brief descriptions and illustrations were prepared for one or more species of each genus, with priority given to those species with few prior records in the Cerrado.

RESULTS

We examined 303 bryophyte specimens from the municipality of Chapadinha, and 54 species were identified, including two hornworts, 27 mosses, and 25 liverworts. These were distributed in 19 families and 33 genera. Two new bryophyte species are newly recorded from Maranhão. These are the moss *Fissidens subulatus* Mitt. and the liverwort *Plagiochila subplana* Lindenb. The family with the greatest species diversity was found to be Lejeuneaceae (Marchantiophyta), which had 12 species, followed by Fissidentaceae (Bryophyta) with six species (Table 1).

Taxonomic notes are given for some species occurring in the Maranhão Cerrado, with representatives of each genus in the study area

Anthocerotophyta
Notothyladaceae

Notothylas javanica (Sande Lac.) Gottsche, Bot. Zeitung (Berlin) 16: 20. 1858.

Figure 2A

Material examined. BRAZIL – MARANHÃO • Chapadinha, Boa Vista neighborhood, Sítio Dr. Pedro Monteles; 03°43'10"S, 043°19'47"W; 105 m alt.; 09.V.2018; FV Carvalho 33 leg.; CCAA1489 • *ibid.*; surroundings of RESEX Chapada Limpa, Poço Comprido village; 04°02'54.4"S, 043°34'58.4"W; 36 m alt.; 29.III.2020; JAS Silva 407 leg.; CCAA2684 • *ibid.*; RESEX Chapada Limpa, Caraíbas village; 03°56'07"S, 043°26'14"W; 52 m alt.; 29.III.2020; JAS Silva 436 leg.; CCAA2742.

Table 1. Bryophyte species of the municipality of Chapadinha. Note: * = New occurrences from Maranhão state; ** = New occurrences from the Brazilian Cerrado.

Taxon	Substrate	Life form	Global distribution
ANTHOCEROTOPHYTA			
Notothyladaceae			
<i>Notothylas javanica</i> (Sande Lac.) Gottsche	Terrestrial	Rosettes	Endemic to Brazil
<i>Notothylas orbicularis</i> (Schwein.) Sull.	Terrestrial	Rosettes	North America, Europe, Japan, Tropical Africa, Brazil
BRYOPHYTA			
Bartramiaceae			
<i>Philonotis elongata</i> (Dumort.) H.A.Crum & Steere	Rupicolous	Tuft	Neotropical
<i>Philonotis hastata</i> (Duby) Wijk & Margad.	Rupicolous	Tuft	Pantropical
<i>Philonotis uncinata</i> (Schwägr.) Brid.	Rupicolous	Tuft	Cosmopolitan
Bryaceae			
<i>Bryum coronatum</i> Shwagr.	Rupicolous	Tuft	Pantropical
Calymperaceae			
<i>Calymperes erosum</i> Müll.Hal.	Corticolous	Tuft	Pantropical
<i>Calymperes palisotii</i> Schwägr.	Corticolous, epixylic	Tuft	Pantropical
<i>Octoblepharum albidum</i> Hedw.	Epixylic, corticolous	Cushion, tuft	Pantropical
<i>Syrrhopodon incompletus</i> Schwägr.	Corticolous	Tuft	Pantropical
<i>Syrrhopodon prolifer</i> Schwägr.	Rupicolous	Tuft	Pantropical
Fissidentaceae			
<i>Fissidens anguste-limbatus</i> Mitt.	Terrestrial	Isolate or loose tuft	Neotropical
<i>Fissidens crispus</i> Mont.	Epixylic, rupicolous, terrestrial	Isolate or loose tuft	Neotropical, Asia
<i>Fissidens elegans</i> Brid.	Terrestrial	Isolate or loose tuft	Neotropical
<i>Fissidens submarginatus</i> Bruch	Terrestrial	isolate or loose tuft	North America, South America, Africa
<i>**Fissidens subulatus</i> Mitt.	Terrestrial	Isolate or loose tuft	Neotropical
<i>Fissidens zollingeri</i> Mont.	Rupicolous	Isolate or loose tuft	Neotropical
Hypnaceae			
<i>Ectropothecium leptochaeton</i> (Schwägr.) W.R.Buck	Corticolous	Weft	Neotropical
<i>Isopterygium tenerum</i> (Sw.) Mitt.	Corticolous	Tuft	Cosmpolitan
Pottiaceae			
<i>Hyophila involuta</i> (Hook.) A.Jaeger	Rupicolous	Tuft	Cosmpolitan
<i>Hyohiladelphus agrarius</i> (Hedw.) R.H.Zander	Rupicolous	tuft	Central America, North America, South America
Pterobryaceae			
<i>Henicodium geniculatum</i> (Mitt.) W.R.Buck	Corticolous	Dendroid	Neotropical
Pylasiadelphaceae			
<i>Microcalpe subsimplex</i> (Hedw.) W.R.Buck	Corticolous, epixylic, rupicolous	Mats	Africa, North America, South America
<i>Taxithelium planum</i> (Brid.) Mitt.	Corticolous, Epixylic	Mats	Africa, North America, South America
Sematophyllaceae			
<i>Trichosteleum subdemissum</i> (Besch.) A.Jaeger	Corticolous, epixylic, rupicolous	Mats	Africa, North America, South America
Splachnobryaceae			
<i>Splachnobryum obtusum</i> (Brid.) Müll.Hal.	Terrestrial	tuft	North America, South America, Western Islands
Stereophyllaceae			
<i>Entodontopsis leucostega</i> (Brid.) W.R.Buck & Ireland	Epixylic	Weft	Pantropical
<i>Pilosium chlorophyllum</i> (Hornsch.) Müll.Hal.	Epixylic, rupicolous	Weft	Neotropical, New Zealand, Madagascar
Thuidiaceae			
<i>Thuidium tomentosum</i> Besch.	Corticolous	Mats	North America, South America

Taxon	Substrate	Life form	Global distribution
MARCHANTIOPHYTA			
Cephaloziellaceae			
<i>Cylindrocolea planifolia</i> (Steph.) R.M.Schust.	Terrestrial	Mats	Neotropical
<i>Cylindrocolea rhizantha</i> (Mont.) R.M.Schust.	Terrestrial	Mats	Neotropical
Fossombroniaceae			
<i>Fossombronia porphyrorhiza</i> (Nees) Prosk.	Terrestrial, rupicolous	Weft	Neotropical
Frullaniaceae			
<i>Frullania ericoides</i> (Nees) Mont.	Corticolous	Mats	Pantropical
<i>Frullania gibbosa</i> Nees	Corticolous	Mats	Neotropical
Lejeuneaceae			
<i>Acrolejeunea emergens</i> (Mitt.) Steph.	Corticolous	Mats	Pantropical
<i>Caudalejeunea lehmaniana</i> (Gottsche) A.Evans	Corticolous	Weft	Pantropical
<i>Ceratolejeunea laetefusca</i> (Austin) R.M.Schust.	Corticolous	Weft	Neotropical
<i>Cololejeunea cardiocarpa</i> (Mont.) A.Evans	Corticolous	Weft	Pantropical
<i>Cololejeunea diaphana</i> A.Evans	Epiphyllous, epixylic	Mats	Pantropical
<i>Dibrachiella parviflora</i> (Nees) X.Q.Shi, R.L.Zhu & Gradst.	Corticolous	Weft	Neotropical
<i>Lejeunea laeta</i> (Lehm. & Lindenb.) Gottsche	Corticolous	Mats	Neotropical
<i>Lejeunea laetevirens</i> Nees & Mont.	Corticolous	Weft	Neotropical
<i>Lejeunea phyllobola</i> Nees & Mont.	Corticolous	Weft	Neotropical
<i>Microlejeunea bullata</i> (Taylor) Steph.	Corticolous	Weft	Neotropical
<i>Myriocoleopsis minutissima</i> (Sm.) R.L.Zhu, Y. Yu & Pócs	Corticolous	Weft	Pantropical
<i>Thysananthus auriculatus</i> (Wilson & Hook) Sukkharak & Gradst.	Corticolous	Weft	Pantropical
Lepidoziaceae			
<i>Zoopsidella integrifolia</i> (Spruce) R.M.Schust.	Terrestrial	Weft	Neotropical
Plagiochilaceae			
<i>Plagiochila raddiana</i> Lindenb.	Corticolous	Pendants	Neotropical
* <i>Plagiochila subplana</i> Lindenb.	Corticolous	Pendants	Neotropical
Ricciaceae			
<i>Riccia mauryana</i> Steph	Terrestrial	Rosettes	North America, South America
<i>Riccia plano-biconvexa</i> Steph.	Terrestrial	rosettes	Tropical South America, subtropical
<i>Riccia stenophylla</i> Spruce	Terrestrial	Rosettes	Tropical America
<i>Riccia vitalli</i> Jovet-Ast	Terrestrial	Rosettes	Brazil, Costa Rica, Paraguay
<i>Riccia weinionis</i> Steph.	Terrestrial	Rosettes	Neotropical

Identification. Thalli forming rosettes, green to yellow green; involucre asymmetric, rough, longitudinally lamellate, becoming lacerated towards the tip. Capsules small, 1.0–2.0 mm in length, cylindrical oblong, with irregular, non-valvular dehiscence; spores yellow, spherical, and tetrahedral; pseudoelaters absent.

Description and illustration. Ruklani et al. (2016: figs. 2–5, 11, 12, 17–21).

Geographical distribution in Brazil. States of Acre, Bahia, Ceará, Goiás, Maranhão, Mato Grosso do Sul, Pernambuco, Piauí, and São Paulo.

Ecological comment. Plants were collected on soil, in a shaded, humid habitats.

Notothylas orbicularis (Schwein.) Sull., Amer. J. Sci. Arts, ser. 2 (1): 75. 1845 [1846].

Material examined. BRAZIL – MARANHÃO • Chapadinha, surroundings of the RESEX Chapada Limpa, Caraibas village (Cocal forest palm); 03°56’07”S, 043°26’14”W; 52 m alt.; 29.III.2020; JAS Silva 432b leg.; CCAA2663.

Identification. Thalli forming small rosettes, green to yellow-green or darker, with a maximum diameter of 1 cm, involucre lamellate distally. Capsules dehisce by longitudinal bivalves; spores yellow to light brown; pseudoelaters present.

Description and illustration. Ruklani et al. (2016); Amélio and Peralta (2020: fig. 1I–N); Gradstein (2021).

Geographical distribution in Brazil. States of Amazonas, Bahia, Ceará, Goiás, Maranhão, Mato Grosso, Pará, and Pernambuco.

Ecological comment. Plants growing on soil in an with high humidity, preferably in shady locations.

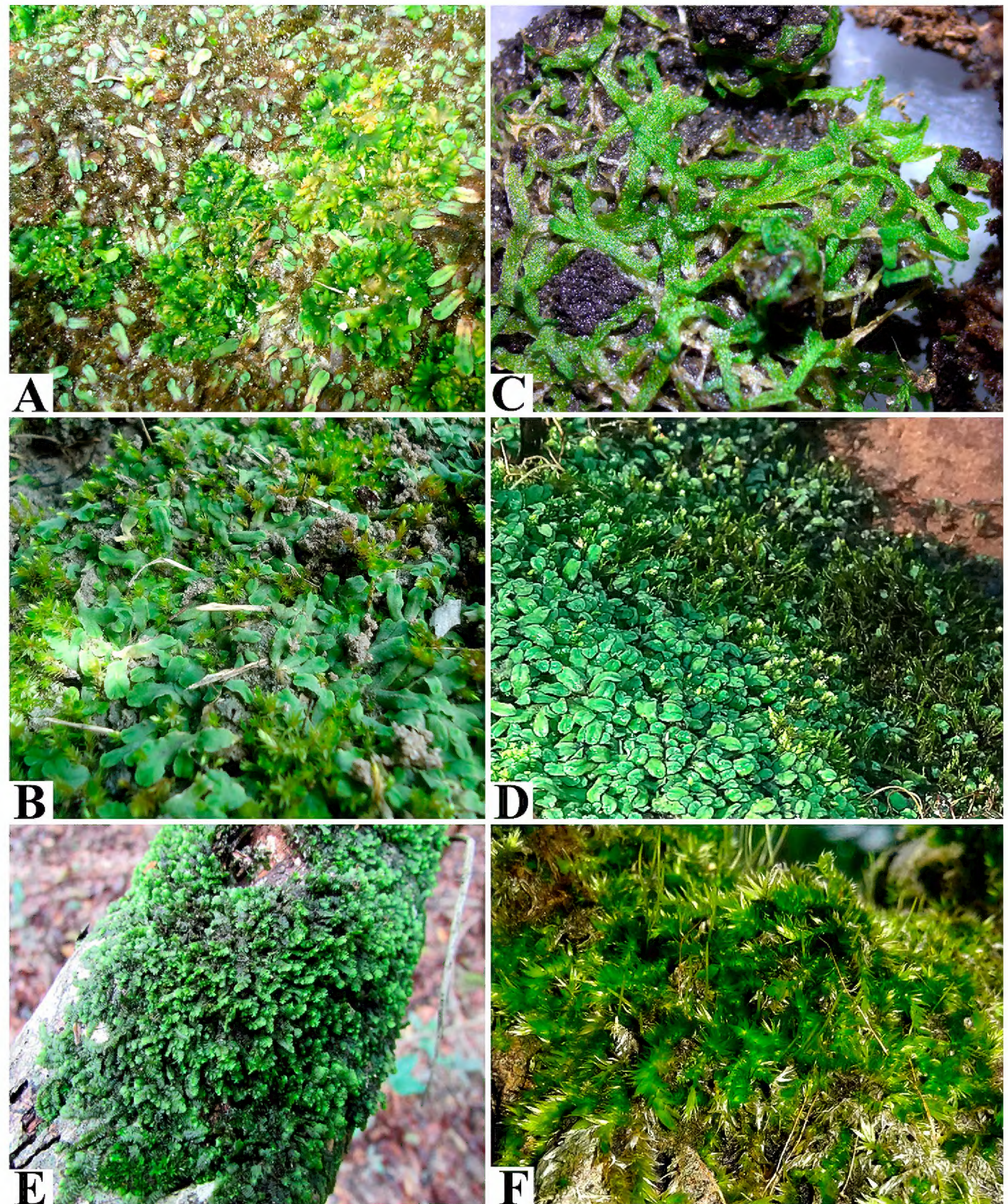


Figure 2. Types of substrates. **A–D.** Terrestrial substrates: **(A)** *Notothylas javanica* (Sande Lac.) Gottsche and *Riccia weinionis* Steph.; **(B)** *Riccia mauryana* Steph.; **(C)** *Riccia stenophylla* Spruce; **(D)** *Riccia vitalli* Jovet-Ast. **E.** Corticolous substrate: *Dibrachiella parviflora* (Nees) X.Q. Shi, R.L. Zhu & Gradst. **F.** Epixylic substrate: *Microcalpe subsimplex* (Hedw.) Spruce.

Bryophyta
Bartramiaceae

Philonotis elongata (Dumort.) H.A.Crum & Steere, Bryologist 59: 251. 1956.

Material examinado. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Centro Velho; 03°56'39"S, 043°26'53"W; 55 m alt.; 29.III.2020; JAS Silva 404, 478 leg.; CCAA 2674, 2615.

Identification. Plants light green to whitish when dry. Leaves narrowly lanceolate; apex long acuminate; margins weakly revolute, toothed with double teeth; costa percurrent.

Description and illustration. Ballejos and Bastos (2010: fig. 3A–D)

Geographical distribution in Brazil. States of Amazonas, Bahia, Ceará, Maranhão, Mato Grosso, Paraíba, Paraná, Rio de Janeiro, and São Paulo. **Ecological comment.** Plants were collected growing on a rocky outcrop near the edge of a stream.

Philonotis hastata (Duby) Wijk & Margad., Taxon 8: 74. 1959.

Figure 3A, B

Material examined. BRAZIL – MARANHÃO • Chapadinha, Aldeia village; 03°44'52"S, 043°21'32"W; 90 m alt.; 22. II.2018; FV Carvalho 18 leg.; CCAA1492 • ibid.; RESEX Chapada Limpa, Centro Velho; 03°56'39"S, 043°26'53"W; 55 m alt.; 29. III. 2020; JAS Silva 403 leg.; CCAA2687.

Identification. Plants green to whitish when dry. Leaves loosely erect even when dry, in clusters or slightly spaced, lanceolate to elliptic; apex acute to long acuminate; margins toothed, with double teeth typically formed by paired or single cells near the base and at apex; costa simple, subpercurrent to percurrent.

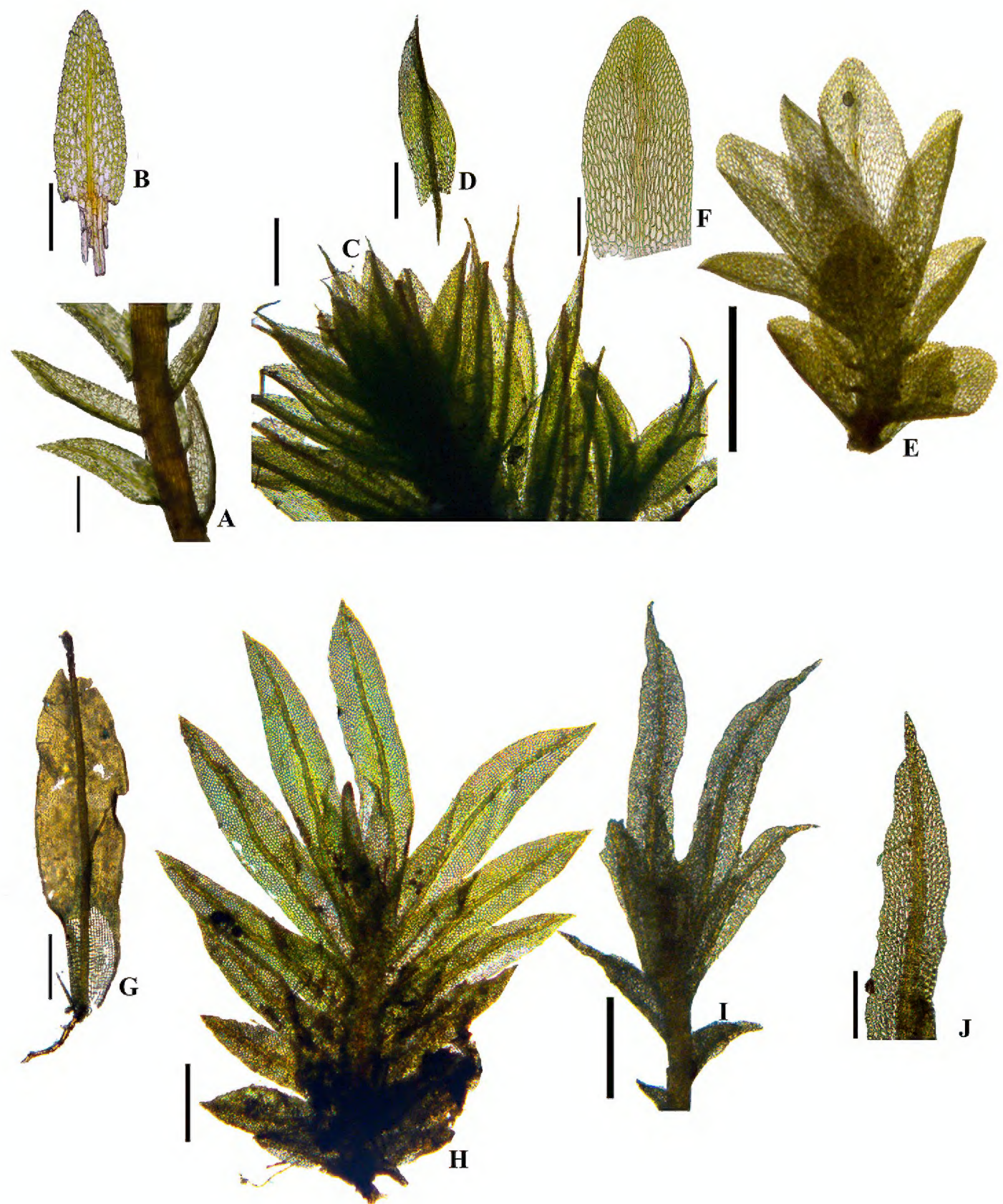


Figure 3. Gametophytes and leaves of the mosses of the municipality of Chapadinha. **A, B.** *Philonotis hastata* (Duby) Wijk & Margad. **C, D.** *Bryum coronatum* Schwagr. **E, F.** *Splachnobryum obtusum* (Brid.) Müll. Hal. **G.** *Calymperes erosum* Müll. Hal. **H.** *Fissidens crispus* Mont. **I, J.** *Fissidens subulatus* Mitt. Scale bars: A, B, E = 2 mm; C = 0.2 mm; D, F, G, I = 0.05 mm; H = 0.5 mm; J = 0.01 mm)

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2016: fig. 1A–D).

Geographical distribution in Brazil. States of Amazonas, Bahia, Ceará, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia, and São Paulo. **Ecological comment.** Plants were collected submerged in running water at the edge of a stream with a concrete border and on a rocky outcrop in a shady, waterlogged with high humidity, in an anthropized area.

***Philonotis uncinata* (Schwägr.) Brid., Bryol. Univ. 2: 22. 1827.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Mata do Jeroca village; 03°59'41"S, 043°29'24"W; 57 m alt.; 29.III.2020; JAS Silva 418 leg.; CCAA2748.

Identification. Plants light green to whitish. Leaves ovate-lanceolate, elliptic when dry and recurved in hook form, erect when wet; apex acuminate to long-acuminate; margins entire and simple, formed by a single row of cells; costa simple, subpercurrent to excurrent.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2016: fig. 1E–H).

Geographical distribution in Brazil. States of Acre, Amapá, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia, Santa Catarina, São Paulo, and Tocantins.

Ecological comment. Plants were collected growing on a rocky outcrop near a stream in a humid and shaded place.

Bryaceae

Bryum coronatum Shwägr., Sp. Musc. Frond., Suppl. 1 (2): 103–104, pl. 71 (top). 1816.

Figure 3C, D

Material examined. BRAZIL – Maranhão • Chapadinha, Campus UFMA, CCAA; 03°44'12"S, 043°18'47"W; 107 m alt.; 07.VI.2017; FV Carvalho 57 leg.; CCAA1889.

Identification. Plants green to reddish-brown. Leaves equidistant, becoming clustered toward the apex of the stem, twisted spirally around the stem when dry, erect when wet, lanceolate to ovate-lanceolate; apex acute to long-acuminate; margins flat to blunt at base, weakly serrate near the apex, bordered by 1 to 2 rows of linear cells; costa excurrent; laminal cells rhomboid-hexagonal, basal cells quadrate.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2017: fig. 1A–D).

Geographical distribution in Brazil. States of Acre, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso, Minas Gerais, Paraíba, Paraná, Pernambuco, Piauí, Rio Grande do Sul, Rondônia, Roraima, São Paulo, Sergipe, and Tocantins. **Ecological comment.** Plants were collected on rocks in an open, urban.

Calymperaceae

Calymperes erosum Müll.Hal., Linnaea 21: 182. 1848.

Figure 3G

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1039, 1044 leg.; CCAA1869, 1864 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14.V.2016; RS Fernandes 1050 leg.; CCAA1866 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'58"S, 043°20'24"W; 77 m alt.; 20.IX.2019; Biology Class 2019.2 58 leg.; CCAA2295 • *ibid.*; Brejo do Meio village; 03°56'15.9"S, 043°30'34.9"W; 69 m alt.; 29.X.2016; Biology Class 2016.2 10 leg.; CCAA1435 • *ibid.*; Santo Antônio neighborhood; 03°45'0.07"S, 043°21'32.76"W; 93 m alt.; 28.IV.2017; Biology Class 2017.1 4 leg.; CCAA1446 • *ibid.*; Campus UFMA-CCAA; 03°44'14"S, 043°18'47"W; 107 m alt.; 21.II.2018; FV Carvalho 12 leg.; CCAA1845 • *ibid.*; Aldeia neighborhood; 03°44'54"S, 043°21'38"W; 90 m alt.; 22.II.2018; FV Carvalho 27 leg.; CCAA1471 • *ibid.*; Boa Vista neighborhood, Sítio Dr. Pedro Monteles; 03°43'10"S, 043°19'48"W; 105 m alt.; 09.V.2018; FV Carvalho 37, 38, 39, 42 leg.; CCAA1454, 1455, 1453, 1842 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 11, 12; 16, 18, 56, CCAA2115, 2114, 2110, 2108, 2081 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 21.IX.2019; Biology Class 2019.2 17, 18 leg.; CCAA2304, 2303.

Identification. Plants yellow-green or dark green. Leaves dimorphic, ligulate to lanceolate, costa subpercurrent to excurrent, margins thickened and serrated, teniolae conspicuous, laminal dorsal cells papillose, laminal ventral cells mamilliose-papillose, cancellinae distinct.

Description and illustration. Reese (1993: fig. 60A–F); Oliveira-da-Silva and Ilkiu-Borges (2018a: fig. 1A–E).

Geographical distribution in Brazil. States of Acre, Amapá, Amazonas, Bahia, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro, Rondônia, and Roraima.

Ecological comment. Plants were collected growing on tree trunks in a humid, well-preserved, dense forest with a stream.

Calymperes palisotii Schwägr., Sp. Musc. Frond., Suppl. 1 (2): 334. 1816.

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 2.IV.2016; RS Fernandes 1017, 1022 leg.; CCAA1875, 125 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14.IV.2016; RS Fernandes 1048, 1053 leg.; CCAA1952, 1950 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 25, 39 leg.; CCAA2103, 2092 • *ibid.*; RESEX Chapada Limpa; Estrela village (River Bridge); 03°53'46"S, 043°29'22"W; 41m alt.; 11.VII.2019; JAS Silva 386 leg.; CCAA2806. *ibid.*; surroundings of the RESEX Chapada Limpa, Veredão village; 04°04'17"S, 043°26'08"W; 57 m alt.; 29.III.2020; JAS Silva 420b leg.; CCAA2686.

Identification. Plants dark to yellow green. Leaves dimorphic, involute and twisted when dry, oblong to lanceolate; gemmae clustered forming tufts at the apex on the ventral surface; margins slightly thickened and serrated at the shoulders; costa smooth except at the apex; teniolae conspicuous on the shoulders, cancellinae distinct.

Description and illustration. Reese (1993: fig. 62A–F).

Geographical distribution in Brazil. States of Alagoas, Amapá, Amazonas, Bahia, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rondônia, Roraima, São Paulo, Sergipe, and Tocantins.

Ecological comment. Plants were collected on tree trunks decaying in a shaded, moist, dense forest.

***Octoblepharum albidum* Hedw., Sp. Musc. Frond. 50. 1801.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 2.IV.2016; RS Fernandes 1021; 1022 leg.; CCAA1945, 125 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 24, 38, 40, 43, 57, 58, 61, 75, 83, 85, 86, 94, 97, 99 CCAA 2104, 2104, 2094, 2091, 2090, 2080, 2079, 2077, 2069, 2065, 2063, 2062, 2052, 2055, 2051 • *ibid.*; Aldeia neighborhood; 15.X.2016; ALF Rodrigues 134 leg.; CCAA1466 • *ibid.*; 22.II.2018; FV Carvalho 23 leg.; CCAA1473 • *ibid.*; Capitão do Campo village; 03°44'30"S, 043°21'37"W; 105 m alt.; 21.V.2016; ALF Rodrigues 47; 138 leg.; CCAA4598, 1460 • *ibid.*; Pitombeira; 28.IV.2017; Biology Class 2017.1 2 leg.; CCAA1439 • *ibid.*; Campus UFMA-CCAA; 21.II.2018; FV Carvalho 15, 16 leg.; CCAA1844, 1841 • *ibid.*; Angelim neighborhood; 21.V.2018; FV Carvalho 50 leg.; CCAA1883 • *ibid.*; Balneário Repouso do Guerreiro; 21.IX.2019; Biology Class 2019.2 13 leg.; CCAA2308 • *ibid.*; RESEX Chapada Limpa, Mata do Jeroca village; 03°59'41"S, 043°29'24"W; 57 m alt.; 29.III.2020; JAS Silva 416, 425 leg.; CCAA2685, 2680.

Identification. Plants whitish, sometimes with a pink tinge at the base of the leaves. Leaves lingulate and spiral, costa broad, multistratified, with a denticulate apex, margins entire, lamina cells square to rectangular, lacking papillae, alar region differentiated, alar cells square to rectangular. Seta short; capsule ovoid.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2018a: fig. 2E–K).

Geographical distribution in Brazil. States of Acre, Alagoas, Amapá, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, São Paulo, Sergipe, and Tocantins.

Ecological comment. Plants were collected growing on the stipe of “Babaçu” (*Attalea speciosa* Spreng.), as well as colonizing decaying tree trunks, both in dense, humid forests and in drier, sunny places. In areas with moisture and water availability, leaves were greenish-whitish, while in dry, they were yellowish.

***Syrrhopodon incompletus* Schwägr., Sp. Musc. Frond., Suppl. 2 (2): 119. 1824.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Road to Guarimã; 04°04'17"S, 043°23'08"W; 57 m alt.; 29.III.2020; JAS Silva 423, 424 leg.; CCAA2676, 2682.

Identification. Plants yellowish to dark green. Leaves straight and twisted when dry, narrowly lanceolate to lanceolate from a distinctly broadened base; apex quite acute; margins thickened, with single or paired teeth above, entire or serrated below, border lacking; costa subpercurrent to short-excurrent.

Description and illustration. Buck (2003: fig. 55A–F).

Geographical distribution in Brazil. States of Acre, Amazonas, Amapá, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraná, Pernambuco, Rondônia, Roraima, Rio de Janeiro, Santa Catarina, São Paulo, and Tocantins.

Ecological comment. Plants were collected growing on the stipe of “Babaçu” in a humid, shaded habitats.

***Syrrhopodon prolifer* Schwägr., Spec. Musc. Suppl. 2 (2): 99. 1827.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Centro Velho, 03°56'39"S, 043°26'53"W; 55 m alt.; 29.III.2020; JAS Silva 405b leg.; CCAA2689.

Identification. Plants yellowish to dark green but often seeming whitish from extensively exposed cancelline. Leaves straight to contorted when dry, narrowly lanceolate to linear, sometimes flexed, from a somewhat enlarged base; apex acute; margins toothed above, mostly entire below, limbate throughout by 2–4 rows of elongate, cells subquadrate to rectangular, pluripapillose on surface, cancellina hyaline; costa percurrent.

Description and illustration. Buck (2003: figs. 60A–D, 61A–E).

Geographical distribution in Brazil. States of Acre, Alagoas, Amapá, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia, Santa Catarina, São Paulo, Sergipe, and Tocantins.

Ecological comment. Plants were collected on a humid, rocky outcrop along the edge of a stream.

Fissidentaceae***Fissidens anguste-limbatus* Mitt., J. Linn. Soc., Bot. 12: 601. 1869.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa; 03°59'26"S, 043°29'48"W; 60 m alt.; 29.III.2020; JAS Silva 393 leg.; CCAA2688 • *ibid.*; Centro Velho; 03°56'39"S, 043°26'53"W; 55 m alt.; 29.III.2020; JAS Silva 399, 401 leg.; CCAA2677, 2681 • *ibid.*; Road to Guarimã; 04°04'17"S, 043°23'08"W; 57 m alt.; JAS Silva 421 leg.; CCAA2692.

Geographical distribution in Brazil. States of Acre, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Minas Gerais, Paraná, Rio Grande do Sul, Rondônia, Roraima, São Paulo, and Tocantins.

Ecological comment. Plants were collected growing on soil in a humid, shady near the edge of a stream.

***Fissidens crispus* Mont., Ann. Sci. Nat., Bot., sér. 2 (9): 57. 1838.**

Figure 3H

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 2.IV.2016; RS Fernandes 1016 leg.; CCAA126 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14.V.2016; RS Fernandes 1052a leg.; CCAA138 • *ibid.*; Capitão do Campo village; 03°44'30"S, 043°21'37"W; 105 m alt.; 21.V.2016; ALF Rodrigues 45, 51, 52 leg.; CCAA1893, 1878, 1879 • *ibid.*; Xororó; 03°44'03"S, 043°22'00"W; 90 m alt.; 14.IX.2016; ALF Rodrigues 85, 88 leg.; CCAA1456, 1488 • *ibid.*; Campus UFMA, CCAA; 03°44'14"S, 043°18'48"W; 107 m alt.; 21.II.2018; FV Carvalho 13, 14, 17, 20 leg.; CCAA1847, 1843, 1848, 1478 • *ibid.*; Sítio Bom Preço; 03°43'57"S, 043°18'37"W; 90 m alt.; 05.II.2019; FV Carvalho 48 leg.; CCAA2554 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 19, 33, 70, 79, 91, 92 leg.; CCAA2107, 2097, 2071, 2073, 2054, 2053 • *ibid.*; 21.IX.2019; Biology Class 2019.2 21, 33 leg.; CCAA2301, 2281.

Identification. Plants pale to dark green, with hyaline axillary nodes on stem. Leaves oblong-ovate, sometimes crisp when dry; apex acute to obtuse-acuminate; limbidium on the margin, costa percurrent, infrequently short-excurrent; lamina cells smooth with thickened walls.

Description and illustration. Pursell (2007: fig. 38A–E).

Geographical distribution in Brazil. States of Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso, Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, Rondônia, Roraima, Rio Grande do Sul, Santa Catarina, São Paulo, and Tocantins.

Ecological comment. Plants were found colonizing rocks, decaying tree trunks, and soil in a dense, humid forest.

***Fissidens elegans* Brid., Muscol. Recent. Suppl. 1: 167. 1806.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Caraíbas village; 03°56'07"S, 043°26'14"W; 52 m alt.; 29.III.2020; JAS Silva 429 leg.; CCAA2740.

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, and São Paulo.

Ecological comment. Plants were collected on exposed soil near the edge of a stream.

***Fissidens submarginatus* Bruch, Flora 29: 133. 1846.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa; 03°59'41"S, 043°29'24"W; 57 m alt.; 29.III.2020; JAS Silva 414 leg.; CCAA2739 • *ibid.*; surroundings of the RESEX Chapada Limpa, Veredão village; 04°04'17"S, 043°26'08"W; 57 m alt.; 29.III.2020; JAS Silva 419 leg.; CCAA2678.

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, Paraíba, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Santa Catarina, and São Paulo.

Ecological comment. Plants were collected on soil in a dense, moist forest shaded habitats.

***Fissidens subulatus* Mitt., J. Linn. Soc., Bot. 12: 589. 1869.**

Figure 3I, J

Material examined. BRAZIL – MARANHÃO • Chapadinha, Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14.V.2016; RS Fernandes 1063 leg.; CCAA132.

Identification. Plants light green to brown, with protonema on the gametophyte. Leaves asymmetrical, elliptic to lanceolate, with a tapering tip; limbidium on the margin of perichaetial leaves; costa long-excurrent.

Description and illustration. Pursell (2007: fig. 120A–H).

Geographical distribution in Brazil. States of Acre, Amazonas, Maranhão, Pará, Rondônia, and Roraima, and is a new record for the Brazilian Cerrado. **Ecological comment.** Plants were collected exposed on moist soil in the open.

***Fissidens zollingeri* Mont., Ann. Sci. Nat., Bot., sér. 3, 4: 114. 1845.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa; 03°59'41"S, 043°29'24"W; 57 m alt.; 29.III.2020; JAS Silva 408, 410 leg.; CCAA2691, 2669.

Geographical distribution in Brazil. States of Acre, Alagoas, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, São Paulo, Sergipe, and Tocantins.

Ecological comment. Plants were collected on rocks in a waterlogged area within a dense forest.

Hypnaceae

***Ectropothecium leptochaeton* (Schwägr.) W.R.Buck**, (Schwägr.) W.R. Buck, Brittonia 35: 311. 1983.

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Mata do Jeroca village, Balneário Bandeira; 03°59'26"S, 043°29'48"W; 60 m alt.; 11.VII.2019; JAS Silva 390 leg.; CCAA2802.

Identification. Plants green to light brown. Leaves on the main and secondary branches slightly differentiated, generally rolled and twisted, erect to falcate or falcate-secund, lanceolate to ovate-lanceolate; apex short to long acuminate; margins flat to irregularly curved, slightly serrate; costa short and double or often, absent.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2018b: fig.1D–G).

Geographical distribution in Brazil. States of Amazonas, Bahia, Espírito Santo, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraná, Rio de Janeiro, and Santa Catarina.

Ecological comment. Plants were partially submerged, in a marshy habitat.

***Isopterygium tenerum* (Sw.) Mitt.**, J. Linn. Soc. Bot. 12: 499. 1869.

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa; Estrela village, (River Bridge); 03°53'46"S, 043°29'22"W; 41m alt.; 11.VII.2019; JAS Silva 385 leg.; CCAA2804 • *ibid.*; Mata do Jeroca village (Balneário Bandeira); 03°59'27"S, 043°29'49"W; 60 m alt.; 11.VII.2019; JAS Silva 389, 391b leg.; CCAA2803, 2826.

Identification. Plants glossy green. Leaves erect, sometimes complanate, imbricate, symmetrical, lanceolate to ovate-lanceolate, concave, apex acuminate to long acuminate, costa double and irregular, $\frac{1}{9}$ – $\frac{1}{6}$ of the leaf length, occasionally absent, margins entire to weakly serrated at the apex, lamina cells smooth.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2018b: fig. 1D–F).

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia, Roraima, São Paulo, Santa Catarina, and Tocantins.

Ecological comment. Plants were partially submerged, growing on roots in a marshy habitat with buriti palms (*Mauritia flexuosa* L.f.).

Pottiaceae

***Hyophila involuta* (Hook.) A.Jaeger**, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1871–1872: 354 (Gen. Sp. Musc. 1: 202). 1873.

Material examined. BRAZIL – MARANHÃO • Chapadinha, Corrente; 044°13'S, 43°20'47"W; 90 m alt.; 29.IV.2017; Biology Class 2017.110 leg.; CCAA1490.

Identification. Plants yellowish to dark green. Leaves strongly curved and tubular when dry, oblong-ovate to spatulate, obtuse to acute; apex usually mucronate, subpercurrent to short-excurrent, margins entire or distantly toothed, flat to broadly curved; costa single.

Description and illustration. Buck (2003: fig. 64A–H).

Geographical distribution in Brazil. States of Alagoas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rondônia, Roraima, Rio Grande do Sul, and São Paulo.

Ecological comment. Plants were collected on the sidewalk in an urban area.

***Hyophiladelphus agrarius* (Hedw.) R.H.Zander**, Bryologist 98: 372. 1995.

Material examined. BRAZIL – MARANHÃO • Chapadinha, Corrente neighborhood; 03°44'08"S 43°20'33"W; 95 m alt.; 29.V. 2019; FV Carvalho 77 leg.; CCAA2568.

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Maranhão, Mato Grosso, Pará, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, São Paulo, Sergipe, and Tocantins.

Ecological comment. Plants were collected on concrete in an urban area.

Pterobryaceae

***Henicodium geniculatum* (Mitt.) W.R.Buck**, Bryologist 92(4):534. 1989.

Material examined. BRAZIL – MARANHÃO • Chapadinha, Chapada Limpa; Estrela village (River Bridge); 03°53'45"S, 043°29'21"W; 41 m alt.; 11.VII.2019; JAS Silva 384 leg.; CCAA2819.

Identification. Plants light green, greenish brown to reddish brown. Leaves erect, ovate to ovate-lanceolate, strongly concave, sometimes plicate in upper half; apex acute to broadly acuminate, distally truncate; margins denticulate, recurved or reflexed below the apex and revolving in the lower half of the leaf; costa single, subpercurrent; alar cells numerous, extending upward along the margins, quadrate to subquadrate, short-rectangular in the decurved areas, with hyaline thick walls.

Description and illustration. Bôas-Bastos and Bastos (2016: fig. 2A–E).

Geographical distribution in Brazil. States of Acre, Alagoas, Amazonas, Amapá, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro, Rondônia, and São Paulo.

Ecological comment. Plants were collected on tree trunks in a moist, shady forest.

Pylasiadelphaceae

***Microcalpe subsimplex* (Hedw.) W.R.Buck**, Taxon 66(4): 824. 2017.

Figure 4D, E

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 2.IV.2016; RS Fernandes 1011 leg.; CCAA1954 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14.V.2016, RS Fernandes 1042, 1048 leg.; CCAA1865, 1952 • *ibid.*; Angelim neighborhood; 03°43'24"S, 043°28'31"W; 59 m alt.; 13.IX.2016; ALF Rodrigues 77, 79 leg.; CCAA1926, 1921 • *ibid.*; Brejo do Meio village; 03°56'16"S, 043°30'35"W; 69 m alt.; 29.X.2016; Biology Class 2016.2 3, 5, 12 leg.; CCAA1442, 1436, 1443 • *ibid.*; Campus UFMA-CCAA; 03°44'14"S, 043°18'47"W; 105 m alt.; 21.II.2018; FV Carvalho 11 leg.; CCAA1846 • *ibid.*; Aldeia neighborhood; 03°44'52"S, 043°21'36"W; 90 m alt.; 22.II.2018; FV Carvalho 21, 25 leg.; CCAA1476, 1475 • *ibid.*; Boa Vista neighborhood, Sítio Dr. Pedro Monteles; 03°43'09"S, 043°19'48"W; 105 m alt.; 09.V.2018; FV Carvalho 31, 32 leg.; CCAA1452, 1451 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 1, 2, 3, 4, 7, 10, 13, 20, 21, 30, 31, 34, 35, 42, 44, 48, 50, 52, 55, 88 leg.; CCAA2123, 2122, 2121, 2120, 2117, 2116, 2113, 2106, 2105, 2100, 2099, 2096, 2095, 2089, 2088, 2086, 2083, 2082, 2084, 2060 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'58"S, 043°20'24"W; 77 m alt.; 20.IX.2019; Biology Class 2019.2 4, 5, 10, 11 leg.; CCAA2298, 2313, 2310, 2309 • *ibid.*; ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 21.IX.2019; Biology Class 2019.2 20, 37, 39, 40, 42, 45, 46, 49, 51 leg.; CCAA 2302, 2282, 2283, 2288, 2286, 2294, 2293, 2275, 2297.

Identification. Plants bright green. Leaves erect to broadly spreading, base concave, ovate-lanceolate; apex gradually acuminate; margins entire or serrulate above and entire below, flat or recurved; lamina cells long-linear, generally flexuose, usually smooth, rarely unipapillose; costa short and double or absent; alar cells large, inflated, ovate to oblong, forming a triangular group, yellow-golden.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2018c: fig. 1F–I).

Geographical distribution in Brazil. States of Acre, Alagoas, Amapá, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, São Paulo, Sergipe, and Tocantins.

Ecological comment. Plants were exposed on the roots and trunks of trees, decomposing fallen logs, and rocks. Most samples were primarily collected in dense forests.

***Taxithelium planum* (Brid.) Mitt.**, Journal of the Linnean Society, Botany 12: 496. 1869.

Figure 4F, G

Material examined. BRAZIL – Maranhão • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 27.XII.2015; FV Carvalho 62, 63, 66 leg.; CCAA1914, 1900, 1927 • *ibid.*; 03°44'27"S, 043°19'36"W; 82 m alt.; 21.IX.2019; Biology Class 2019.2 63, 64 leg.; CCAA2314, 2291 • *ibid.*; trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1041 leg.; CCAA1874; • *ibid.*; Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14. V. 2016; RS Fernandes 1048, 1051 leg.; CCAA1952, 1947 • *ibid.*; Capitão do Campo village; 03°44'30"S, 043°21'37"W; 105 m alt.; 03°44'30"S, 043°21'37"W; 105 m alt.; 21.V.2016; ALF Rodrigues 49 leg.; CCAA1871 • *ibid.*; Angelim neighborhood; 3°43'24"S, 43°28'31"W; 59 m alt.; 13.IX.2016; ALF Rodrigues 70, 74, 78 leg.; CCAA1459, 1468, 1461 • *ibid.*; Brejo do Meio village; 03°56'16"S, 043°30'35"W; 69 m alt.; 29.X.2016; Biology Class 2016.2 9 leg.; CCAA1444.

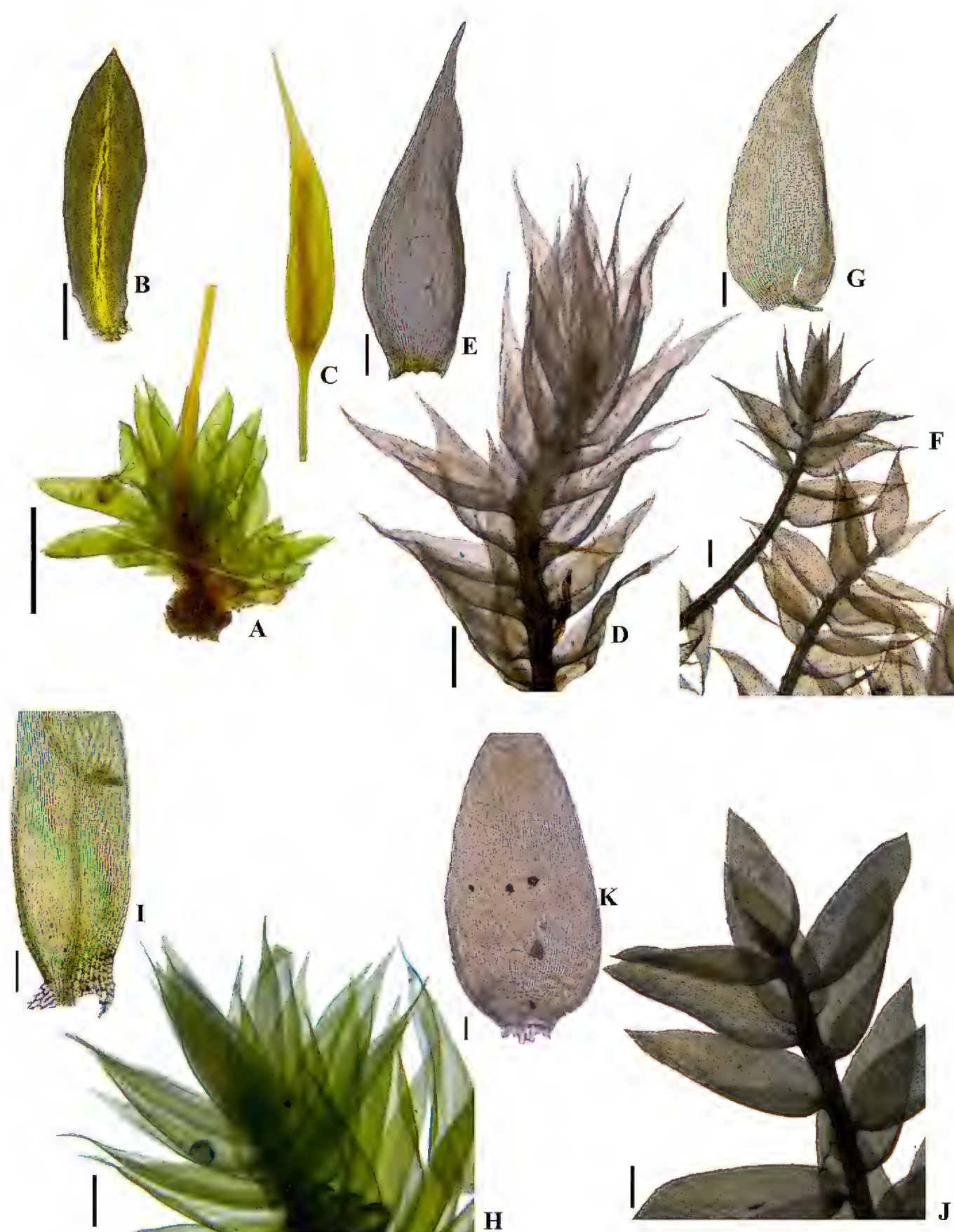


Figure 4. Gametophytes and leaves of mosses from the municipality of Chapadinha. **A–C.** *Hyophila involuta* (Hook.) A. Jaeger. **D, E.** *Microcalpe subsimplex* (Hedw.) Spruce. **F, G.** *Taxithelium planum* (Brid.) Mitt. **H, I.** *Entodontopsis leucostega* (Brid.) W.R. Buck & Ireland. **J, K.** *Pilosium chlorophyllum* (Hornsch.) Müll. Hal. Scale bars: A–C = 2 mm; D, H, J = 0.5 mm; E, I = 0.2 mm; F, K = 0.1 mm; G = 0.05 mm.

Identification. Plants light green. Leaves erect to spreading, concave, narrowly to broadly ovate; apex obtuse or acute; margin serrate near the base; costa short and double or absent; lamina cells linear, pluripapillose, with 3–7 papillae in series per cell; alar cells 2–4, large and inflated, hyaline, occasionally colored, with a small group of hyaline quadrate cells above.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2018c: fig. 2D–H).

Geographical distribution in Brazil. States of Alagoas, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, Pernambuco, Rondônia, Roraima, and São Paulo.

Ecological comment. Plants were collected growing on tree trunks of living or tree trunks decaying trees, both in the open and in dense forests.

Sematophyllaceae

***Trichosteleum subdemissum* (Besch.) A. Jaeger**, Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1876–1877: 418 (Gen. Sp. Musc. 2: 484). 1878.

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 27.XII.2015; FV Carvalho 58, 59, 60, 61 leg.; CCAA1915, 1920, 1925, 1923 • *ibid.*; 2.IV.2016; RS Fernandes 1012, 1013 leg.; CCAA1949, 2548 • *ibid.*; Capitão do Campo village; 03°44'30"S, 043°21'37"W; 105 m alt.; 21.V.2016; ALF Rodrigues 48 leg.; CCAA1886 • *ibid.*; Angelim neighborhood; 03°43'24"S, 43°28'31"W; 59 m alt.; 13.IX.2016; ALF Rodrigues 71, 75, 80 leg.; CCAA1463, 1457, 1464 • *ibid.*; Brejo do Meio village; 03°56'16"S, 043°30'35"W; 73 m alt.; 29.X.2016; Biology Class 2016.2 2 leg.; CCAA1445 • *ibid.*; 03°44'27"S, 043°19'36"W; 82 m alt.; 20.IX.2019; Biology Class 2019.2 16 leg.; CCAA2305 • *ibid.*; ARIE Itamacaoca;

03°44'27"S, 043°19'36"W; 82 m alt.; 21.IX.2019; Biology Class 2019.2 51 leg.; CCAA2297 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'58"S, 043°20'24"W; 77 m alt.; 21.IX.2019; Biology Class 2019.2 52, 53, 54, 59 leg.; CCAA2284, 2296, 2285, 2287 • *ibid.*; ARIE Itamacaoca; 03°44'27"S, 043°19'36"W; 82 m alt.; 21.IX.2019; Biology Class 2019.2 60 leg.; CCAA2290.

Identification. Plants green to light green. Leaves erect-spreading, ovate to ovate-lanceolate; apex acute; margin sub-entire to serrulate, flat to occasionally recurved; costa short; lamina cells linear, becoming smaller and rhomboid towards the apex, unipapillose above; alar cells large, inflated, oblong, 2–3 in the basal angle.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2018d: fig. 3A–D).

Geographical distribution in Brazil. States of Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, Piauí, Rio de Janeiro, Rondônia, Roraima, and São Paulo.

Ecological comment. Plants were collected on tree trunks, decaying logs, and rocks both in the open areas and in dense, moist forests.

Splachnobryaceae

***Splachnobryum obtusum* (Brid.) Müll.Hal.,** Verh. K. K. Zool. –Bot. Ges. Wien 19: 504. 1869.

Figure 3E, F

Material examined. BRAZIL – MARANHÃO • Chapadinha, Corrente; 03°44'18"S, 43°21'01"W; 98 m alt.; 24.IV.2017; Biology Class 2017.117 leg.; CCAA1487.

Identification. Plants yellow green to reddish. Leaves oblong-lingulate; apex obtuse; margins crenulate in the upper region, entire towards the lower region; costa single, ending in 3–4 cells below the apex.

Description and illustration. Lisboa and Ilkiu-Borges (1997: figs. 1, 2A–C).

Geographical distribution in Brazil. States of Acre, Alagoas, Amazonas, Ceará, Goiás, Maranhão, Mato Grosso do Sul, Rio Grande do Sul, and São Paulo.

Ecological comment. Plants were collected on exposed soil, near a paved, open area in an urban habitat.

Stereophyllaceae

***Entodontopsis leucostega* (Brid.) W.R.Buck & Ireland,** Nova Hedwigia 41:103. 1985

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1040 leg.; CCAA2553 • *ibid.*; Capitão do Campo village; 03°44'30"S, 043°21'37"W; 105 m alt.; 21.V.2016; ALF Rodrigues 46 leg.; CCAA1887 • *ibid.*; RESEX Chapada Limpa; 29.II.2020; JAS Silva 437 leg.; CCAA2679.

Identification. Plants pale green to dark green. Leaves ovate-lanceolate to oblong-lanceolate; margins entire or serrated near the apex; costa simple, reaching $\frac{1}{2}$ – $\frac{3}{4}$ of the leaf length; laminal cells and apical smooth or porous on the dorsal surface; alar cells quadrate to short-rectangular, sometimes oblong.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2016: fig. 1D–F).

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Pernambuco, Piauí, Rio de Janeiro, Rondônia, Roraima, São Paulo, and Tocantins.

Ecological comment. Plants were collected on decaying logs, along a trail in a humid, shaded, dense forest.

***Pilosium chlorophyllum* (Hornsch.) Müll.Hal.,** Flora 83: 340. 1897

Figure 4J, K

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1043, 1487 leg.; CCAA1862, 1953 • *ibid.*; Angelim; 03°43'24"S, 043°28'31"W; 59 m alt.; 13.IX.2016; ALF Rodrigues 76 leg.; CCAA1462 • *ibid.*; ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 27.X.2015; FV Carvalho 65 leg.; CCAA1897 • *ibid.*; Aldeia neighborhood; 03°44'55"S, 043°21'38"W; 90 m alt.; 22.II.2018; FV Carvalho 28 leg.; CCAA1477.

Identification. Plants bright green to yellow-green. Leaves symmetrical on main branch, asymmetrical on lateral branches, oblong to oblong-lanceolate; apex acute; margins entire; costa present or absent, when present short and bifurcate; alar cells differentiated only on one side of the leaf, quadrate to rectangular.

Description and illustration. Oliveira-da-Silva and Ilkiu-Borges (2016: fig. 1A–C).

Geographical distribution in Brazil. States of Acre, Alagoas, Amapá, Amazonas, Bahia, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Pernambuco, Rio de Janeiro, Rondônia, Roraima, São Paulo, and Tocantins.

Ecological comment. Plants were found colonizing rocks and decaying logs in a humid, shaded forest.

Thuidiaceae

***Thuidium tomentosum* Besch.**, Mém. Soc. Sci. Nat. Cherbourg 16: 237. 1872.

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1033 leg.; CCAA1868 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14.V.2016; RS Fernandes 1054 leg.; CCAA1863.

Identification. Plants medium-sized, green to yellow green, 2–3-pinnate, paraphyllia abundant. Leaves appressed when dry, erect when moist, concave; apex acute; margins crenulate-papillose, recurved; costa sub-percurrent, reaching about 4/5 of the leaf length, slightly rough in the lower half; laminal cells oval or sub-quadrate, pluripapillose.

Description and illustration. Buck (2003: fig. 119A–K).

Geographical distribution in Brazil. States of Alagoas, Amazonas, Bahia, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, and São Paulo.

Ecological comment. Plants were collected on tree trunks in a moist gallery forest near a stream.

Marchantiophyta
Cephaloziellaceae

***Cylindrocolea planifolia* (Steph.) R.M.Schust.**, Nova Hedwigia 22(1–2): 164. 1971.

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Centro Velho; 03°59'41"S, 043°29'24"W; 57 m alt.; 29.III.2020; JAS Silva 396 leg.; CCAA2812.

Identification. Plants light green to brownish. Leaves succubous, inserted laterally on the stem, ovate, bilobed; apex acute or somewhat obtuse; margin entire, flat to slightly recurved. Underleaf absent.

Description and illustration. Gradstein and Ilkiu-Borges (2009: fig. 12A–C).

Geographical distribution in Brazil. States of Acre, Bahia, Maranhão, Minas Gerais, Rio de Janeiro, Rondônia, Santa Catarina, and São Paulo.

Ecological comment. Plants collected on a rocky outcrop in a moist, shady habitats.

***Cylindrocolea rhizantha* (Mont.) R.M.Schust.**, Nova Hedwigia 22(1–2): 175. 1971 [1972].

Figure 5B

Material examined. BRAZIL – MARANHÃO • Chapadinha, Xororó; 03°44'3"S, 043°22'00"W; 90 m alt.; 14.IX.2016; ALF Rodrigues 88 leg.; CCAA1488 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 27.X.2015; FV Carvalho 64 leg.; CCAA1899 • *ibid.*; 6.IV.2019; Biology Class 2019.132 leg.; CCAA2098.

Geographical distribution in Brazil. States of Acre, Bahia, Espírito Santo, Goiás, Maranhão, Pernambuco, Rio de Janeiro, and São Paulo.

Ecological comment. Plants were growing on soil in association with *Fissidens crispus* Mont. in a dense, moist forest.

Fossombroniaceae

***Fossombronia porphyrorhiza* (Nees) Prosk.**, Bryologist 58: 197. 1955.

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Estrela, (River Bridge) village; 03°53'45"S, 043°29'21"W; 41 m alt.; 11.VII.2019; JAS Silva 373b, 387 leg.; CCAA2822, 2809 • *ibid.*; Centro Velho, 03°56'39"S, 043°26'53"W; 55 m alt.; 29.III.2020; JAS Silva 405a leg.; CCAA2689.

Identification. Plants pale green, with long purple rhizoids on the ventral side. Leaves subquadrate wider than long; margins wavy, distinct, border lacking or with a weak border of elongated cells. Underleaf absent.

Description and illustration. Bordin and Yano (2009: figs. A–F).

Geographical distribution in Brazil. States of Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pernambuco, Piauí, Rio de Janeiro, São Paulo, and Tocantins.

Ecological comment. Plants were collected on a rocky outcrop and in on soil on a bank at the edge of a stream.



Figure 5. Gametophytes and leaves of mosses and leafy liverworts of the municipality of Chapadinha. **A.** *Thuidium tomentosum* Besch. **B.** *Cyllindrocolea rhizantha* (Mont.) R.M.Schust. **C, D.** *Frullania ericoides* (Nees) Mont. **E, F.** *Frullania gibbosa* Nees. **G, H.** *Dibrachiella parviflora* (Nees) X.Q. Shi, R.L.Zhu & Gradst. **I, J.** *Caudalejeunea lehmaniana* (Gottsche) A. Evans. Scale bars: A = 0.5 mm; B, E, F = 2 mm; C, D = 0.1 mm; G, H = 1 mm; I, J = 0.01 mm).

Frullaniaceae

***Frullania ericoides* (Nees) Mont.**, Ann. Sci. Nat., Bot., sér. 2, 12(1): 51. 1839.

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1036 leg.; CCAA129.

Identification. Plants green to reddish-brown. Leaves ovate-orbicular; apex rounded to acuminate, squarrose when moist; margins entire; trigones with irregularly sinuous wall. Lobule close to stem, saccate, sometimes laminate, narrowly attached to the stem (by a few cells); stylus lanceolate, 3–6 cells long. Underleaves $\frac{1}{3}$ bifid, contiguous to subimbricate, obovate to suborbicular.

Description and illustration. Lima et al. (2018: fig. 1A–I).

Geographical distribution in Brazil. States of Acre, Amazonas, Alagoas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Rio Grande do Sul, Rio de Janeiro, Santa Catarina, São Paulo, and Sergipe.

Ecological comment. Plants were collected growing on tree trunks in a shaded gallery forest.

***Frullania gibbosa* Nees**, Syn. Hepat. 411. 1845.

Material examined. BRAZIL – MARANHÃO • Chapadinha, Boa Vista neighborhood, Sítio Dr. Pedro Monteles; 03°44'52"S, 043°21'32"W; 105 m alt.; 09.V.2018; FV Carvalho 40a leg.; CCAA1491.

Identification. Plants yellowish-brown to reddish green. Leaves convolute when dry, and squarrose when moist, ovate-orbicular, more or less concave, dorsal base auriculate; apex rounded, flat; margins entire. Lobule close to stem, saccate, base flattened, broadly attached to the stem; stylus leafy-rounded. Underleaves $\frac{1}{9}$ – $\frac{1}{5}$ bifid, densely imbricate, suborbicular.

Description and illustration. Lima et al. (2018: fig. 4A–I).

Geographical distribution in Brazil. States of Acre, Amapá, Amazonas, Bahia, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro, Roraima, Santa Catarina, and São Paulo.

Ecological comment. Plants were collected growing on tree trunks, associated with *Acrolejeunea emergens* (Mitt.) Steph., in a shaded, moist forest.

Lejeuneaceae

***Acrolejeunea emergens* (Mitt.) Steph.**, Pflanzenw. Ost-Afrikas C: 65. 1895.

Material examined. BRAZIL – MARANHÃO • Chapadinha, Boa Vista neighborhood, Sítio Dr. Pedro Monteles; 03°44'52"S, 043°21'32"W; 105 m alt.; 09.V.2018; FV Carvalho 40b leg.; CCAA1491.

Identification. Plants dark brown. Leaves strongly imbricate, convolute when dry, extending to more or less squarrose when moist, ovate-suborbicular, ovate-orbicular to ovate-subrectangular, apex round; margins entire. Lobule with 2–4 teeth. Underleaves entire, obovate.

Description and illustration. Ilkiu-Borges and Oliveira-da-Silva (2018: fig. 1A–C).

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Pará, Maranhão, Minas Gerais, Mato Grosso do Sul, Mato Grosso, Rio de Janeiro, Rondônia, Roraima, and São Paulo.

Ecological comment. Plants were growing on tree trunks, associated with *Frullania gibbosa*, in a shaded, moist forest.

***Caudalejeunea lehmaniana* (Gottsche) A.Evans**, Bull. Torrey Bot. Club 34:554, Pl.33. 1907.

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 27 leg.; CCAA5520.

Identification. Plants bright green and opaque, turning light yellow to brown when dry. Leaves spreading obliquely and somewhat falcate, convex or flat, oblong-ovate, margins entire, flat on the ventral margin, forming a straight line or a very wide angle with the keel. Lobule elongate, 2 teeth at apex. Underleaves emarginate.

Description and illustration. Gradstein (1994: figs. A–G); Gradstein (2021: fig. 42D, E).

Geographical distribution in Brazil. States of Alagoas, Amazonas, Espírito Santo, Maranhão, Mato Grosso, Pará, Paraná, Pernambuco, Rio de Janeiro, Santa Catarina, São Paulo, Rio Grande do Sul, Rondônia, and Sergipe.

Ecological comment. Plants were collected on tree trunks in a moist, preferably open areas.

***Ceratolejeunea laetefusca* (Austin) R.M.Schust.**, J. Elisha Mitchell Sci. Soc. 72(2): 306. 1956.

Figure 6A, B

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1034, 1035 leg.; CCAA1946, 1861 • *ibid.*; Aldeia neighborhood; 03°44'53"S, 043°21'37"W; 90 m alt.; 22.II.2018; FV Carvalho 22 leg.; CCAA1469 • *ibid.*; Xororó; 03°44'5"S, 043°21'55"W; 90 m alt.; 28.I.2019; FV Carvalho 44 leg.; CCAA2551 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 15 leg.; CCAA2111 • *ibid.*; RESEX Chapada Limpa; Estrela village (River Bridge); 03°53'45"S, 043°29'21"W; 41 m alt.; 11.VII.2019; JAS Silva 383 leg.; CCA2805.

Identification. Plants light brown. Leaves ovate, margins entire or irregularly crenulate, median cells isodiametric, 2–(3) ocelli at leaf base, contiguous or isolated. Lobules inflated or reduced, ovate, $\frac{1}{4}$ – $\frac{1}{3}$ the length of the lobe, with a short tooth at the apex. Underleaves $\frac{1}{2}$ bifid, distant to imbricate, orbicular to ovate, 2–3× the stem width.

Description and illustration. Dauphin (2003: fig. 30A–F).

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Espírito Santo, Goiás, Maranhão, Minas Gerais, Pará, Pernambuco, Rio de Janeiro, Roraima, and São Paulo.

Ecological comment. Plants were collected on tree trunks along a trail in a moist, dense forest.

***Cololejeunea cardiocarpa* (Mont.) A.Evans**, Mem. Torrey Bot. Club 8(2): 172. 1902.

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1046a leg.; CCAA134 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 29 leg.; CCAA2101 • *ibid.*; Biology Class 2019.1 41 leg.; CCAA2093.

Identification. Plants green to yellowish to hyaline. Leaves ovate-oblong, apex narrowly rounded, usually with a group of digitiform hyaline cells; margins entire and lacking a hyaline border, median cells sub-isodiametric, trigones very small. Lobules ovate. Underleaf absent.

Description and illustration. Ilkiu-Borges and Oliveira-da-Silva (2018: fig. 4C–E).

Geographical distribution in Brazil. States of Amazonas, Bahia, Espírito Santo, Goiás, Mato Grosso do Sul, Maranhão, Mato Grosso, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro, Rondônia, Roraima, Santa Catarina, São Paulo, and Sergipe.



Figure 6. Gametophytes and leaves of leafy liverworts of the municipality of Chapadinha. **A, B.** *Ceratolejeunea laetefusca* (Austin) R.M.Schust. **C, D.** *Cololejeunea cardiocarpa* (Mont.) A.Evans. **E.** *Cololejeunea diaphana* A. Evans. **F.** *Myriocoleopsis minutissima* (Sm.) R.L.Zhu, Y. Yu & Pócs. **G, H.** *Lejeunea laeta* (Lehm. & Lindenb.) Gottsche. **I.** *Thysananthus auriculatus* (Wilson & Hook) Sukkharak & Gradst. **J.** *Zoopsidella integrifolia* (Spruce) R.M.Schust. **K.** *Plagiochila raddiana* Lindenb. **L.** *Plagiochila subplana* Lindenb. Scale bars: A, B = 0.02 mm; C, G, I, L = 0.5 mm; D, J = 0.05 mm; E = 0.01 mm; F = 2 mm; H, K = 0.1 mm.

Ecological comment. Plants were growing on tree trunks in a moist, shaded forest.

***Cololejeunea diaphana* A.Evans**, Bull. Torrey Bot. Club 32(4): 184-185, pl. 5, figs 9-14. 1905.

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016; RS Fernandes 1046b, 1047 leg.; CCAA134, 133 • ibid.; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 49, 84 leg.; CCAA2085, 2064.

Identification. Plants light green to hyaline. Leaves lanceolate, longer than wide; apex subacute, ending in a single cell; margins and often lobule keel with coniacally elevated, median cells isodiametric. Lobule first tooth long and straight, second tooth one cell. Underleaf absent.

Description and illustration. Gradstein and Ilkiu-Borges (2009: fig. 41A-D).

Geographical distribution in Brazil. States of Amazonas, Espírito Santo, Goiás, Maranhão, Mato Grosso, Pará, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, and São Paulo.

Ecological comment. Plants were colonizing leaves and decaying logs in a dense forest.

***Dibrachiella parviflora* (Nees) X.Q.Shi, R.L.Zhu & Gradst.**, Taxon 64(5): 889, 2015.

Figure 5G, H

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Estrela village (River Bridge); 03°53'45"S, 043°29'21"W; 41m alt.; 11.VII.2019; JAS Silva 375, 376, 378a, 379a, 380, 381, 388 leg.; CCAA2816, 2807, 2830, 2817, 2827; 2810, 2811.

Identification. Plants pale green, brown to light brown. Leaves contiguous to sub-imbricate, more oblong to ovate-orbicular; margins entire, flat. Lobule reduced, long-ovate to ovate-rectangular, flat apex, with apical tooth also reduced. Underleaves entire, distant to sub-imbricate.

Description and illustration. Ilkiu-Borges (2000: fig. 9A–N).

Geographical distribution in Brazil. States of Amazonas, Maranhão, Pará, Pernambuco, Rondônia, Roraima, and São Paulo.

Ecological comment. Plants were collected on tree trunks along a stream at the forest edge. They were growing in extremely wet, even periodically flooded areas.

***Lejeunea laeta* (Lehm. & Lindenb.) Gottsche, Linden. & Nees, Syn. Hepat.: 380. 1845.**

Figure 6G, H

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 2.IV.2016; RS Fernandes 1024, 1032a leg.; CCAA127, 1951 • *ibid.*; Brejo do Meio village; 03°56'16"S, 043°30'35"W; 69 m alt.; 29.X.2016; Biology Class 2016.2 1 leg.; CCAA1438 • *ibid.*; Angelim; 03°43'24"S, 043°28'31"W; 59 m alt.; 21.V.2018; FV Carvalho 49, 53 leg.; CCAA1884, 1880 • *ibid.*; Xororó; 03°44'05"S, 043°21'55"W; 90 m alt.; 28.I.2019; FV Carvalho 43 leg.; CCAA2550 • *ibid.*; Sítio Bom Preço; 03°43'57"S, 043°18'37"W; 90 m alt.; 05.II.2019; FV Carvalho 46 leg.; CCAA2555 • *ibid.*; Farm near Balneário Pantanal; 03°44'4"S, 043°17'10"W; 85 m alt.; 27.III.2019; FV Carvalho 70, 72 leg.; CCAA2562, 2570 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 14, 60, 90 leg.; CCAA2112, 2078, 2056.

Identification. Plant light green. Leaves imbricate, ovate; margins entire. Lobules usually reduced, but when well-developed, ca. $\frac{1}{4}$ × leaf length, ovate, with a short, obtuse tooth. Underleaves bifid, orbicular. Perianth oblong, stipitate, keels entire to weakly crenulate.

Description and illustration. Bastos and Yano (2009); Gradstein (2021: fig. 52M).

Geographical distribution in Brazil: States of Bahia, Ceará, Maranhão, Minas Gerais, Paraná, Rio de Janeiro, Santa Catarina, and São Paulo. **Ecological comment:** Plants were growing on tree trunks, both in the open and in dense, moist forests.

***Lejeunea laetevirens* Nees & Mont., Sagra Hist. Phys. Cuba, Bot.Pl. Cell. 9: 469. 1842.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 2.IV.2016, RS Fernandes 1032b leg.; CCAA1951 • *ibid.*; Balneário Repouso do Guerreiro; 03°44'57"S, 043°20'25"W; 77 m alt.; 14.V.2016, RS Fernandes 1052b leg.; CCAA138 • *ibid.*; Brejo do Meio village; 03°56'16"S, 043°30'35"W; 69 m alt.; 29.X.2016; Biology Class 2016.2 4 leg.; CCAA1440 • *ibid.*; Biology Class 2016.2 11 leg.; CCAA1437 • *ibid.*; Aldeia neighborhood; 03°44'54"S, 043°21'38"W; 90 m alt.; 22.II.2018; FV Carvalho 24, 26 leg.; CCAA1470, 1474 • *ibid.*; Angelim; 03°43'24"S, 043°28'31"W; 59 m alt.; 21.V.2018, FV Carvalho 51 leg.; CCAA1882 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 87 leg.; CCAA2061 • *ibid.*; ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 21.IX.2019; Biology Class 2019.2 57 leg.; CCAA.2280.

Identification. Plants light green. Leaves generally erect to spreading, ovate; margins entire; cuticle finely papillose. Lobules when well-developed $\frac{2}{5}$ – $\frac{1}{3}$ × leaf length, ovoid and fully inflated, free margin incurved, tooth short, obtuse. Underleaves bifid, lobes acute, usually with a lateral tooth. Perianth obovate, 5 keels.

Description and illustration. Bastos and Yano (2009); Bordin and Yano (2009: fig. 15A–D).

Geographical distribution in Brazil. States of Acre, Alagoas, Amapá, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Pará, Paraíba, Paraná, Pernambuco, Rio de Janeiro, Rio Grande Norte, Roraima, Rio Grande do Sul, Santa Catarina, São Paulo, and Sergipe.

Ecological comment. Plants were collected on tree trunks in a moist, shaded forest.

***Lejeunea phyllobola* Nees & Mont., Hist. Phys. Pol. Natur. Cuba 9: 471. 1842.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, 29.III.2020; JAS Silva 378b, 379b leg.; CCAA2830, 2820 • *ibid.*; RESEX Chapada Limpa; Estrela village (River Bridge); 03°53'45"S, 043°29'21"W; 41m alt.; 11.VII.2019; JAS Silva 382, 383 leg.; CCAA2813, 2805 • *ibid.*; Mata do Jeroca village (Balneário Bandeira); 03°59'27"S, 043°29'49"W; 60 m alt.; 11.VII.2019; JAS Silva 391a leg.; CCAA2818.

Identification. Plants light green to yellowish. Leaves distant to imbricate, ovate-rounded, flat to concave; apex rounded to obtuse; margins entire, crenulate to irregular. Lobules when well developed $\frac{1}{4}$ – $\frac{1}{3}$ × leaf length, inflated, free margin incurved, apical tooth obtuse. Underleaves bifid, ovate, lobes acute.

Description and illustration. Reiner-Drehwald (2000: figs. 10, 11); Bastos and Yano (2009); Gradstein (2021: fig. 53C, D).

Geographical distribution in Brazil. States of Acre, Alagoas, Amazonas, Bahia, Ceará, Distrito Federal, Espí-

rito Santo, Goiás, Maranhão, Minas Gerais, Mato Grosso do Sul, Mato Grosso, Pará, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina, and São Paulo.

Ecological comment. Plants were collected from the trunks of living trees in a well-preserved, moist, shaded forest with a natural stream.

***Microlejeunea bullata* (Taylor) Steph., Hedwigia 29 (2): 90. 1890.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, surroundings of the RESEX Chapada Limpa, Veredão village; 04°04'17"S, 043°26'08"W; 57 m alt.; 29.III.2020; JAS Silva 420a leg.; CCAA2686.

Identification. Plants minute, green. Leaves ovate, 1 basal ocellus; apex rounded, recurved; margins ventral curved. Lobule reduced, absent or rare, $\frac{2}{3}$ of the lobe. Underleaf absent.

Description and illustration. Gradstein and Costa (2003: fig. 59C–E).

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Minas Gerais, Mato Grosso do Sul, Mato Grosso, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Roraima, Santa Catarina, São Paulo, and Sergipe.

Ecological comment. Plants were collected on tree trunks in a well-preserved, shaded, moist forest.

***Myriocoleopsis minutissima* (Sm.) R.L.Zhu, Y.Yu & Pócs, Phytotaxa 183(4): 293. 2014.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, Boa Vista neighborhood, Sítio Dr. Pedro Monteles; 03°43'09"S, 043°19'49"W; 100 m alt.; 09.V.2018; FV Carvalho 41 leg.; CCAA1472 • *ibid.*; Sítio Bom Preço; 03°43'57"S, 043°18'37"W; 90 m alt.; 05.II.2019; FV Carvalho 47 leg.; CCAA2552 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 72, 73, 74, 77, 78, 82 leg.; CCAA2074, 2070, 2076, 2075, 2072, 2066.

Identification. Plants green to yellow-green when dry. Leaves distant to contiguous, ovate to sub-orbicular; apex rounded to obtuse; margins crenulate; median cells rounded. Lobules large, sometimes reduced, inflated, first tooth 2 cells long, second tooth unicellular. Underleaf absent.

Description and illustration. Schuster (1980: figs. 758 1–5); Gradstein (2021).

Geographical distribution in Brazil. States of Acre, Amazonas, Bahia, Espírito Santo, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, Rondônia, Santa Catarina, and São Paulo.

Ecological comment. Plants were collected on tree trunks in a shaded, moist forest.

***Thysananthus auriculatus* (Wilson & Hook) Sukkharak & Gradst., Phytotaxa 326(2): 102. 2017.**

Figure 6I

Material examined. BRAZIL – MARANHÃO • Chapadinha, trail near Pousada Extasy; 03°44'26"S, 043°19'36"W; 83 m alt.; 14.V.2016, RS Fernandes 1036 leg.; CCAA129 • *ibid.*; Aldeia neighborhood; 03°44'54"S, 043°21'38"W; 90 m alt.; 15.X.2016; ALF Rodrigues 132 leg.; CCAA1458 • *ibid.*; Farm near Balneário Pantanal; 03°44'4"S, 043°17'10"W; 85 m alt.; 27.III.2019; FV Carvalho 71 leg.; CCAA2571 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 5, 6 leg.; CCAA2119, 2118 • *ibid.*; Biology Class 03°44'27"S, 043°19'36"W; 2019.2 14 leg.; CCAA2307 • *ibid.*; RESEX Chapada Limpa, Estrela village; 03°53'45"S, 043°29'21"W; 41 m alt.; 11.VII.2019; JAS Silva 374 leg.; CCAA2815.

Identification. Plants dark green to brown. Leaves oblong-ovate; apex rounded or obtuse, imbricate; margins entire; median cells elongated; trigones large, cordate. Lobule flat or inflated. Underleaves entire, apex truncate.

Description and illustration. Gradstein and Costa (2003: fig. 58E–H); Gradstein (2021: fig. 61I, J).

Geographical distribution in Brazil. States of Acre, Amapá, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Minas Gerais, Mato Grosso do Sul, Mato Grosso, Pará, Paraná, Rio de Janeiro, Rondônia, Roraima, São Paulo, and Tocantins.

Ecological comment. Plants were collected on tree trunks in a shady, moist area of closed forest.

Lepidoziaceae

***Zoopsidella integrifolia* (Spruce) R.M.Schust., Nova Hedwigia 10:42.1965.**

Figure 6J

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 21.IX.2019; Biology Class 2019.2 35 leg.; CCAA2279 • *ibid.*; RESEX Chapada Limpa; 03°53'45"S, 043°29'21"W; 41 m alt.; 29.III.2020; JAS Silva 446 leg.; CCAA2624.

Identification. Plants whitish green. Leaves contiguous, ovate-triangular to oblong-rhomboid, undivided or asymmetrically emarginate; apex with 2 small sausage-like hyaline cells; margins entire. Lobule and Underleaf absent.

Description and illustration. Gradstein and Costa (2003: fig. 75G–J); Silva et al. (2021: fig. 3L).

Geographical distribution in Brazil. States of Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, São Paulo, and Sergipe.

Ecological comment. Plants were collected on soil in moist, shaded, dense forest and at the edge of a stream.

Plagiochilaceae

***Plagiochila raddiana* Lindenb., Sp. Hepat. (Lindenberg) (fasc. 1): 9. 1839.**

Figure 6K

Material examined. BRAZIL – MARANHÃO • Chapadinha, Balneário Repouso do Guerreiro; 03°44'58"S, 043°20'24"W; 77 m alt.; 20.IX.2019; Biology Class 2019.2 7 leg.; CCAA2312.

Geographical distribution in Brazil. States of Acre, Alagoas, Amapá, Amazonas, Bahia, Ceará, Espírito Santo, Goiás, Maranhão, Mato Grosso, Minas Gerais, Pará, Paraíba, Pernambuco, Rio de Janeiro, and São Paulo.

Ecological comment. Plants collected at the base of tree trunks in a moist, shaded forest.

***Plagiochila subplana* Lindenb., Spec. Hepat. fasc. 2–4: 73. 1840.**

Figure 6L

Material examined. BRAZIL – MARANHÃO • Chapadinha, ARIE Itamacaoca; 03°44'45"S, 043°19'15"W; 82 m alt.; 2.IV.2016; RS Fernandes 1052c leg.; CCAA138.

Identification. Plants yellow-green to light brown. Leaves horizontally inserted, alternate, rectangular, sometimes ovate-oblong; margins toothed along the entire length or up to the upper half, with 4–8 teeth, ventral leaf base entire. Underleaf absent.

Description and illustration. Gradstein (2015: fig. 1B).

Geographical distribution in Brazil. States of Amapá, Amazonas, Bahia, Espírito Santo, Minas Gerais, Mato Grosso do Sul, Pará, Pernambuco, Roraima, Rio de Janeiro, Santa Catarina, and São Paulo, and new record for Maranhão.

Ecological comment. Plants collected on the tree trunks in a moist, shaded area of dense forest.

Ricciaceae

***Riccia mauryana* Steph., Sp. Hepat. 1: 19. 1898.**

Figure 2B

Material examined. BRAZIL – MARANHÃO • Chapadinha, Campus UFMA, CCAA; 03°43'58"S, 043°19'07"W; 107 m alt.; 4.IV.2017; JAS Silva 134 leg.; CCAA3008 • *ibid.*; 7.VI.2017; FV Carvalho 54, 56 leg.; CCAA1891, 1885 • *ibid.*; Capitão do Campo village; 03°44'30"S, 043°21'37"W; 105 m alt.; 21.V.2016; ALF Rodrigues, 52 leg.; CCAA1879 • *ibid.*; Xororó; 03°44'03"S, 043°22'00"W; 90 m alt.; 14.IX.2016; ALF Rodrigues 83, 87 leg.; CCAA1465, 1485 • *ibid.*; 03°43'09"S, 043°19'47"W; FV Carvalho 36 leg.; CCAA1447. Boa Vista neighborhood, Sítio Dr. Pedro Monteles; 03°43'10"S, 043°19'47"W; 105 m alt.; 09.V.2018; FV Carvalho 34 leg.; CCAA1484 • *ibid.*; Xororó; 03°44'3"S, 043°22'00"W; 90 m alt.; 28.I.2019; FV Carvalho 45 leg.; CCAA2572 • *ibid.*; Centro; 03°44'31"S, 043°21'35"W; 105 m alt.; 21.III.2019; FV Carvalho 67, 68, 69 leg.; CCAA2557, 2556, 2549 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.1 46 leg.; CCAA2087.

Identification. Plants thalloid, dorsal surface light to grayish-green, ventral surface pale green to brownish, thallus bifurcate 2–3 times, wings 5–15 mm long, 2–3 mm wide, rounded apically; margins narrow, hyaline, 2–3 cells wide, with a deep median groove; ventral scales hyaline to pinkish, imbricate, lunulate; dorsal margins sharp, ascending or concave, recurved, acute; ventral margins convex. Spores subspherical.

Description and illustration. Silva et al. (2018b: fig. 2A–C).

Geographical distribution in Brazil. States of Maranhão and Pernambuco.

Ecological comment. Plants were collected on exposed waterlogged, muddy soil in a partially shaded forest, as well as in open areas and between spaces in the pavement of urban areas.

***Riccia plano-biconvexa* Steph., Bih. Kongl. Svenska Vetensk.-Akad. Handl. 23: 29. 1897.**

Material examined. BRAZIL – MARANHÃO • Chapadinha, Sítio Dr. Pedro Monteles; 03°43'10"S, 043°19'49"W; 105 m alt.; 09.V.2018; FV Carvalho 29, 30, 33 leg.; CCAA1450, 1448, 1489 • *ibid.*; surroundings of the RESEX Chapada Limpa, Poço Comprido village, 04°02'54"S, 043°34'58"W; 36 m alt.; 29.III.2020; JAS Silva 411 leg.;

CCAA2745 • *ibid.*; Chapadinha, RESEX Chapada Limpa; 03°59'41"S, 043°29'24"W; 57 m alt.; 29.III.2020; JAS Silva 406, 409, 410 leg.; CCAA2694, 2670, 2669 • *ibid.*; RESEX Chapada Limpa, Caraibas village (Cocal forest palm); 03°56'07"S, 043°26'14"W; 52 m alt.; 29.III.2020; JAS Silva 432a leg.; CCAA2663.

Geographical distribution in Brazil. States of Alagoas, Bahia, Ceará, Distrito Federal, Espírito Santo, Goiás, Maranhão, Mato Grosso, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina, and Tocantins.

Ecological comment. Plants were collected on exposed soil in a moist, shaded habitats.

***Riccia stenophylla* Spruce**, Bull. Soc. Bot. France 36 (suppl.): 195. 1890.

Figure 2C

Material examined. BRAZIL – MARANHÃO • Chapadinha, Capitão do Campo village; 03°44'30"S, 043°21'37"W; 105 m alt.; 21.V.2016, ALF Rodrigues 50 leg.; CCAA1890 • *ibid.*; Aldeia neighborhood; 03°44'54"S, 043°21'38"W; 90 m alt.; 15.X.2016, ALF Rodrigues 136 leg.; CCAA1486 • *ibid.*; RESEX Chapada Limpa, Estrela village; 03°53'45"S, 043°29'21"W; 41 m alt.; 11.VII.2019; JAS Silva 368, 369a, 373a leg.; CCAA2831, 2821; 2822.

Geographical distribution in Brazil. States of Bahia, Ceará, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Paraíba, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, and São Paulo. **Ecological comment.** Plants collected on exposed waterlogged soil in a moist, shaded habitats.

***Riccia vitalii* Jovet-Ast**, Mem. New York Bot. Gard. 46: 283. 1987.

Figure 2D

Material examined. BRAZIL – MARANHÃO • Chapadinha, • *ibid.*; RESEX Chapada Limpa, Mata do Jeroca village; 03°59'26"S, 043°29'48"W; 60 m alt.; 11.VII.2019; JAS Silva 392 leg.; CCAA3229 • *ibid.*; ARIE Itamacaoca; 03°44'55"S, 043°19'55"W; 82 m alt.; 6.IV.2019; Biology Class 2019.117, 28 leg.; CCAA2109, 2102 • *ibid.*; RESEX Chapada Limpa, Centro Velho, 03°56'39"S, 043°26'53"W; 55 m alt.; 29.III.2020; JAS Silva 398, 426, 430 leg.; CCAA2668, 2665, 2671.

Geographical distribution in Brazil. States of Alagoas, Bahia, Ceará, Amazonas, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Rio Grande do Sul, Sergipe, and Tocantins.

Ecological comment. Plants were collected on exposed soil in partial shade at the edge of a stream.

***Riccia weinionis* Steph.**, Sp. Hepat. 1: 18. 1898.

Figure 2A

Material examined. BRAZIL – MARANHÃO • Chapadinha, RESEX Chapada Limpa, Estrela village; 03°53'45"S, 043°29'21"W; 41 m alt.; 11.VII.2019; JAS Silva 372 leg.; CCAA2814 • *ibid.*; Boa Vista neighborhood; 27.II.2020; RS Fernandes 1083 leg.; CCAA2746.

Geographical distribution in Brazil. States of Bahia, Ceará, Espírito Santo, Goiás, Maranhão, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Paraíba, Paraná, Rio de Janeiro, São Paulo, and Sergipe.

Ecological comment. Plants were collected on exposed soil in dense forest, as well as in more open environments.

DISCUSSION

Mosses had the greatest diversity of all bryophytes in Chapadinha. We identified 27 species of moss, but liverworts had 25 species (Table 1). Our data confirm previous studies on bryophytes of the Cerrado of Maranhão, which show a higher diversity among mosses (Santos and Conceição 2010; Peralta et al. 2011; Varão et al. 2011; Costa et al. 2015, 2018; Vieira et al. 2017; Oliveira et al. 2018; Silva et al. 2018a). We found two species of hornwort, *Notothylas javanica* and *N. orbicularis*, from Maranhão; Peralta et al. (2011) and Vieira et al. (2017) had earlier reported *N. javanica* (Figure 2A) (as *Notothylas vitalii* Udar & Singh).

Among the species recorded for the first time from Maranhão, *Plagiochila subplana* (Figure 6L), whose distribution was previously thought to be restricted to the Amazon and Atlantic Forest (Flora e Funga do Brasil 2024), and *Fissidens subulatus* (Figure 3I, J), which is a novelty both for the Cerrado biome and for the Northeast region of Brazil (Pursell 2007; Flora e Funga do Brasil 2024). We collected this species on a tree trunk, while Pinheiro and Câmara (2012) found it both on tree trunks and the soil.

Lejeuneaceae was the family with the greatest species richness (12 species), which confirms what has been observed in other studies in the Maranhão Cerrado (Santos and Conceição 2010; Peralta et al. 2011; Costa et al. 2018; Oliveira et al. 2018c) and elsewhere in the Brazilian Cerrado (Bôas-Bastos and Bastos 1998; Câmara and Vital 2004; Câmara et al. 2005; Peralta and Yano 2005; Genevro et al. 2006; Carmo et al. 2018; Fernandes et al. 2021a).

In recent years, the number of bryophyte species recorded in Cerrado areas of Maranhão has increased

(Varão et al. 2011; Costa et al. 2015, 2018; Vieira et al. 2017; Oliveira et al. 2018a, 2018d; Silva et al. 2018a, 2018b). However, all these studies were concentrated in just one municipality in eastern Maranhão (e.g. Brito et al. 2009; Conceição et al. 2010; Costa et al. 2015, 2018; Oliveira et al. 2018a, 2018b; 2018c; Silva et al. 2018a; Bonfim et al. 2019). They have demonstrated how undersampled the state remains, as their results increased the number of known bryophyte species in the Maranhão Cerrado and Northeastern Brazil by about 36%, compared to what was previously recorded in the literature (Costa 2010). Our results from Chapadinha reinforce the need to expand bryophyte studies in the state, as 19.7% of the bryophytes known in the Maranhão Cerrado (274 species) and 18.2% of the bryophytes recorded in Maranhão (296 species) were found and two additional species were recorded (Yano et al. 2009; Brito et al. 2009; Conceição et al. 2010; Santos e Conceição 2010; Varão et al. 2011; Peralta et al. 2011; Brito and Ilkiu-Borges 2012; Macedo and Ilkiu-Borges 2014; Brito and Ilkiu-Borges 2014; Costa et al. 2015, 2018, 2021; Vieira et al. 2017; Oliveira et al. 2018a, 2018d, 2020; Silva et al. 2018a, 2018b, 2021; Bonfim et al. 2019; Amélio and Peralta 2020; Fernandes et al. 2021b; Flora e Funga do Brasil 2024).

Octobleplarum albidum Hedw, which has a Pantropical distribution and is widely distributed in Brazil, and *Microcalpe subsimplex* (Hedw.) Spruce (Figure 2F), which has a African–American distribution and is present throughout Brazil, are frequent in the Cerrado as well as other Brazilian phytogeographic domains. This is due to their ability to colonize varied substrates (Santos and Conceição 2010; Conceição et al. 2010; Peralta et al. 2011; Varão et al. 2011; Costa et al. 2015, 2018; Vieira et al. 2017; Oliveira et al. 2018a, 2018b, 2018d; Silva et al. 2018a; Oliveira et al. 2021) and adapt to different environments that offer minimal microclimatic conditions (mainly humidity).

Some species were recorded for only the second time in the Maranhão Cerrado, such as *Philonotis elongata*, *Ectropothecium leptochaeton*, *Riccia mauryana*, and *Plagiochila raddiana*; their geographic distribution in the state is expanded (Figure 6K), and the number of specimens in collections is increased. *Fissidens crispus* was first recorded in the state on soil by Silva et al. (2018a) in the municipality of Caxias. However, in Chapadinha, the species was collected on both soil and on a decaying tree trunk.

Among the thalloid liverworts in the state of Maranhão, Peralta et al. (2011) mentioned three species of Ricciaceae: *Riccia plano-biconvexa*, *R. stenophylla* (Figure 2C), and *R. vitalli*. We found these species in our study, besides *Riccia weinionis* (Figure 2A) and *R. mauryana* (Figure 2B). The latter species was cited by Silva et al. (2018b) as a new record for the state of Maranhão, as it had previously only been recorded in Pernambuco (Bischler-Causse et al. 2005; Flora e Funga do Brasil 2024) and was considered uncommon.

The preference for tree trunks as substrate was confirmed for most species, as observed elsewhere in the Cerrado (Conceição et al. 2010; Santos and Conceição 2010; Varão et al. 2011; Costa et al. 2015; Vieira et al. 2017). In tropical forests, tree trunks are the most available substrate, readily allowing for bryophyte colonization (Gradstein et al. 1995). Additionally, according to Geneviro et al. (2006), some angiosperms have robust, often fissured bark, which makes this substrate ideal for bryophytes.

The most common bryophyte life form in the study area were tufts, weft, and mats. The Tuft life form is quite common in low humidity environments (Glime 2017) and serves as a response to intense solar radiation that causes dehydration; tufts help to capture and retain water (Silva et al. 2018c). Liverworts and mosses presenting weft and mat life forms show preferences for shaded, humid sites (Kürschner and Frey 2012). The live forms seen here indicate the duality of the Cerrado, which although has prevailing xeric conditions, still harbors humid sites serving as shelter for many species.

Most species were observed in the two conservation areas of the municipality, RESEX Chapada Limpa and ARIE Itamacaoca. These species included the locally rare *Cylindrocolea rhizantha* (Figure 5B), *Dibrachiella parviflora* (Figure 2E), and *Plagiochila subplana* (Figure 6M). These species were not recorded in urban environments in the municipality, such as in Corrente, Aldeia, or Angelim neighborhoods. In urban locations, most species have broad ecological amplitude, such as *Octoblepharum albidum*, *Microcalpe subsimplex* (Figure 2F), and *Taxithelium planum* (Figure 4F, G). *Riccia mauryana*, which is considered rare (Bischler-Causse et al. 2005; Silva et al. 2018b), was collected in urban areas on soil and pavements.

Based our results, we conclude that the Cerrado areas in Chapadinha have a high number of species, including interesting species not previously recorded in Maranhão. Our new records highlight the need to increase collections in the state of Maranhão, covering all vegetation formations. The high diversity of liverwort species, especially thalloid liverworts, reflects a low similarity with other Cerrado areas in Maranhão, which justifies the importance of continuing floristic studies in the state, especially in areas not covered by the present study.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions


Conceptualization: FVC, JASS, DPC, ALIB, RSF. Data curation: FVC, JASS. Formal analysis: FVC, JASS, DPC, ALIB. Funding acquisition: FVC, RSF. Investigation: FVC, JASS, DPC, ALIB. Methodology: FVC, JASS, RSF. Resources: FVC, JASS, RSF. Supervision: JASS, ALIB, RSF. Visualization: ALIB, RSF. Project administration: FVC, ALIB, RSF. Validation: FVC, JASS, DPC, ALIB, RSF. Writing – original draft: FVC, JASS, DPC, ALIB, RSF. Writing – review and editing: FVC, JASS, DPC, ALIB, RSF.


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Data availability

All data that support the findings of this study are available in the main text.

REFERENCES

- Amélio LA, Peralta DF** (2020) The genus *Notothyas* (Notothykladaceae, Anthocerotophyta) in Brazil. *Brazilian Journal of Botany* 43: 331–340. <https://doi.org/10.1007/s40415-020-00602-x>
- Ballejos J, Bastos CJP** (2010) Musgos acrocárpicos (Bryophyta) do Parque Estadual das Sete Passagens, Miguel Calmon, Bahia, Brasil. *Revista Brasileira de Botânica* 33: 355–370. <https://doi.org/10.1590/S0100-84042010000200016>
- Barbosa BB, Costa Coelho CJ, Moraes LA, Santos LA** (2020) Unidades de Conservação no Brasil: um enfoque para a Região dos Cocais, no Leste Maranhense. *Research, Society and Development* 9: e568997473. <https://doi.org/10.33448/rsd-v9i9.7473>
- Bastos CJP, Yano O** (2009) O gênero *Lejeunea* Libert (Lejeuneaceae) no Estado da Bahia, Brasil. *Hoehnea* 36: 303–320. <https://doi.org/10.1590/S2236-89062009000200008>
- Bischler-Causse H, Gradstein SR, Jovet-Ast SL, Long DG, Allen NS** (2005) Marchantiidae. *Flora Neotropica, Monograph* 97: 1–262.
- Bôas-Bastos SBV, Bastos CJP** (1998) Briófitas de uma área de cerrado no município de Alagoinhas, Bahia, Brasil. *Tropical Bryology* 15: 101–110.
- Bôas-Bastos SBV, Bastos CJP** (2016) Pterobryaceae Kindb. (Bryophyta) no Brasil. *Pesquisas, Botânica* 69: 13–71.
- Bonfim MAS, Oliveira RF, Oliveira RR, Gomes GS, Araújo MFV, Silva MLA, Nascimento JM, Silva GS, Santos-Silva DL, Gaspar JC, Sousa DHS, Silva AM, Martins PRP, Conceição GM** (2019) Bryophytes in Maranhão/Brazil: A New Area, a New Species List. *International Journal of Advanced Engineering Research and Science* 6: 188–192.
- Bordin J, Yano O** (2009) Novas ocorrências de antóceros e hepáticas para o Estado do Rio Grande do Sul, Brasil. *Brazilian Journal of Botany* 32: 189–211. <https://doi.org/10.1590/S0100-84042009000200002>
- Brito ES, Conceição GM, Peralta DF** (2009) Notes on geographic distribution: Pottiaceae, *Hyophila involuta* (Hook.) Jaeg. & Sauerb. (New occurrence in the state of Maranhão, Brazil), *Hyophila apiculata* Fleisch (New occurrence in Brazil). *Pesquisa em Foco* 17: 80–83. <https://doi.org/10.18817/pef.v17i2.223>
- Brito ES, Ilkiu-Borges AL** (2012) A new species of *Ceratolejeunea* Jack & Steph (Lejeuneaceae, Jungermanniopsida) from a remnant of Amazonian forest in Maranhão, Brasil. *Nova Hedwigia* 95: 423–428. <https://doi.org/10.1127/0029-5035/2012/0061>
- Brito ES, Ilkiu-Borges AL** (2014) Briófitas de uma área de Terra Firme no município de Mirinzal e novas ocorrências para o estado do Maranhão, Brasil. *Iheringia Série Botânica* 69: 133–142.
- Buck WR** (2003) Guide to the Plants of Central French Guiana. Edition 3. Mosses. *Memoirs of the New York Botanical Garden* 76: 1–167.
- Câmara PEAS, Oliveira JRPM, Santiago MMM** (2005) A Checklist of the bryophytes of Distrito Federal (Brasília, Brazil). *Tropical Bryology* 26: 133–140.
- Câmara PEAS, Vital DM** (2004) Briófitas do Município de Poconé, Pantanal de Mato Grosso, MT, Brasil. *Acta Botanica Brasilica* 18: 881–886. <https://doi.org/10.1590/S0102-33062004000400019>
- Carmo DMD, Lima JSD, Silva MID, Amélio LDA, Peralta DF** (2018) Briófitas da Reserva Particular do Patrimônio Natural da Serra do Caraça, Estado de Minas Gerais, Brasil. *Hoehnea* 45: 484–508. <https://doi.org/10.1590/2236-8906-35/2018>
- Carvalho-Silva M, Stech M, Soares-Silva LH, Buck WR, Wickett NJ, Liu Y, Câmara PEAS** (2017) A Molecular Phylogeny of the Sematophyllaceae SI (Hypnales) based on plastid, mitochondrial and nuclear markers, and its taxonomic implications. *Taxon* 66: 811–831. <https://doi.org/10.12705/664.2>

- Conceição GM, Rugieri AC, Brito ES** (2010) Musgos pleurocárpicos do município de Caxias, Maranhão, Brasil. *Acta Tecnológica* 5: 32–42.
- Costa DP** (2010) Lista de espécies: briófitas. In: Forzza RC, et al. (Eds.) Instituto de Pesquisas Jardim Botânico do Rio de Janeiro. Catálogo de plantas e fungos do Brasil [online]. SciELO Books 1: 452–521. <https://reflora.jbrj.gov.br/downloads/vol1.pdf>. Accessed on: 20-12-2024
- Costa DP, Peralta DF** (2015) Bryophytes diversity in Brazil. *Rodriguésia* 66: 1063–1071. <https://doi.org/10.1590/2175-7860201566409>
- Costa FB, Silva EO, Conceição GM** (2015) Hepáticas (Marchantiophyta) e musgos (Bryophyta) da Área de Proteção Ambiental do Buriti do Meio, município de Caxias, Maranhão, Brasil. *Scientia Plena* 11: 1–4.
- Costa AMR, Oliveira RR, Sá NAS, Conceição GM** (2018) Briófitas do Cerrado Maranhense, Nordeste do Brasil. *Revista NBC, Belo Horizonte* 8 (16): 33–43.
- Costa FB, Silva GS, Santos-Silva DL, Gomes GS, Peralta DF, Oliveira HC** (2021) Hepáticas (Marchantiophyta) do Parque Nacional Chapada das Mesas: novos registros para o Bioma Cerrado. *Revista principia* 56: 191–201.
- Crandall-Stotler B, Stotler R, Long D** (2009) Morphology and classification of the Marchantiophyta. In: Goffinet B, Shaw AJ. *Bryophyte Biology*, Edition 2. Cambridge University Press, Cambridge, UK, 1–54.
- Dauphin G** (2003) *Ceratolejeunea* (Lejeuneaceae: Lejeuneneoideae). *Flora Neotropica*, Monograph 90: 1–86.
- Dauphin G, Morales T, Moreno EJ** (2008) Catálogo preliminar de Lejeuneaceae (Hepaticae) de Venezuela. *Cryptogamie, Bryologie* 29: 215–265.
- Fernandes LR, Athayde-Filho F, Peralta DF** (2021a) Cachoeiras como refúgio para briófitas no Cerrado Brasileiro. *Research, Society and Development* 10: e272101119647. <https://doi.org/10.33448/rsd-v10i11.19647>
- Fernandes RS, Silva JAS, Ottoni FP, Costa DP** (2021b) Diversity of thalloid liverworts in Brazilian Savanna of Parque Nacional da Chapada das Mesas, Maranhão, Brazil. *Check List* 17: 45–58. <https://doi.org/10.15560/17.1.45>
- Filgueiras TS, Nogueira PE, Brochado AL, Guala II GF** (1994) Caminhamento: um método expedito para levantamentos florísticos qualitativos. *Cadernos de Geociências* 12: 39–43.
- Flora e Funga do Brasil** (2024) Jardim Botânico do Rio de Janeiro. <http://floradobrasil.jbrj.gov.br/>. Accessed on: 14-06-2024.
- Genevro JA, Athayde Filho FP, Peralta DF** (2006) Briófitas de mata de galeria no Parque Municipal Mário Viana, Nova Xavantina, Mato Grosso, Brasil. *Boletim do instituto de Botânica* 18: 149–157.
- Glime JM** (2017a) *Bryophyte Ecology. Physiological ecology*. Michigan, E-book sponsored by Michigan Technological University and the International Association of Bryologists. <https://digitalcommons.mtu.edu/bryophyte-ecology1/>. Accessed on: 12-08-2024.
- Glime JM** (2017b) Field Taxonomy and Collection Methods. In: Glime JM (Ed.) *Bryophyte Ecology*. Michigan Technological University and the International Association of Bryologists, 1–22. <https://digitalcommons.mtu.edu/cgi/viewcontent.cgi?article=1000&context=bryophyte-ecology3>. Accessed on: 12-08-2024.
- Goffinet B, Buck WR, Shaw AJ** (2009) Morphology, anatomy, and classification of the Bryophyta. In: Goffinet B, Shaw AJ (Eds.) *Bryophyte Biology*. Cambridge University Press, Cambridge, UK, 56–138. <https://doi.org/10.1017/cbo9780511754807.003>
- Gradstein SR** (1994) Lejeuneaceae; Ptychantheae, Brachiolejeuneae. *Flora Neotropica*, monograph 62: 1–216.
- Gradstein SR** (1995) Bryophyte diversity of the tropical rainforest. *Archives des Sciences Genève* 48: 91–96.
- Gradstein SR** (2015) Annotated key to the species of *Plagiochila* (Marchantiophyta) from Brazil. *Pesquisas, Botânica* 67: 23–36.
- Gradstein SR** (2021) The liverworts and hornworts of Colombia and Ecuador. *Memoirs of the New York New York Botanical Garden* 121: 1–871.
- Gradstein SR, Costa DP** (2003) The Hepaticae and Anthocerotae of Brazil. *Memoirs of the New York Botanical Garden* 87: 1–318.
- Gradstein RS, Ilkiu-Borges AL** (2009) Guide to the plants of Central French Guiana. Part 4. Liverworts and Hornworts. *Memoirs of the New York Botanical Garden* 76: 1–140.
- Gradstein SR, Churchill SP, Salazar AN** (2001) Guide to the bryophytes of tropical America. *Memoirs of the New York Botanical Garden* 86: 1–577.
- Harris BJ, Harrison CJ, Hetherington AM, William, TA** (2020) Phylogenomic evidence for the monophyly of bryophytes and the reductive evolution of stomata. *Current Biology* 30: 2001–2012. <https://doi.org/10.1016/j.cub.2020.03.048>
- IBGE** (1992) Divisão do Brasil em Mesorregiões e Microrregiões Geográficas. Fundação Instituto Brasileiro de Geografia e Estatística. Departamento de Geografia, Rio de Janeiro, Brasil. 303. <https://cidades.ibge.gov.br/brasil/ma/chapadinha>. Accessed on: 13-07-2022.
- IBGE** (2011a) Geomorfologia: mapa geomorfológico do estado do Maranhão. Instituto Brasileiro de Geografia e Estatística. https://geoftp.ibge.gov.br/informacoes_ambientais/geomorfologia/mapas/unidades_da_federacao/ma_geomorfologia.pdf. Accessed on: 20-11-2024.
- IBGE** (2011b) Pedologia: mapa exploratório de solos do estado do Maranhão. Instituto Brasileiro de Geografia e Estatística. https://geoftp.ibge.gov.br/informacoes_ambientais/pedologia/mapas/unidades_da_federacao/ma_pedologia.pdf. Accessed on: 20-11-2024.
- IBGE** (2019) Mapa biomas e sistema costeiro marinho. Instituto Brasileiro de Geografia e Estatística. https://geoftp.ibge.gov.br/informacoes_ambientais/estudos_ambientais/biomas/mapas/biomas_e_sistema_costeiro_marinho_250mil.pdf. Accessed on: 23-06-2022.
- Ilkiu-Borges AL** (2000) Lejeuneaceae (Hepaticae) da Estação Científica Ferreira Penna, Caxiuanã, município de Melgaço, Pará. Master's thesis, Universidade Federal Rural da Amazônia, Belém, Brazil, 251pp.
- Ilkiu-Borges AL, Oliveira-da-Silva FR** (2018) Flora das cangas da Serra dos Carajás, Pará, Brasil: Lejeuneaceae. *Rodriguésia* 69: 989–1012.
- IPNI** (2020) International Plant Names Index. <https://www.ipni.org/>. Accessed on: 26-01-2020.

- ISA** (2022) Unidades de Conservação no Brasil. Reserva Extrativista Chapada Limpa. Instituto Socioambiental. <https://uc.socioambiental.org/pt-br/arp/4776>. Accessed on: 06-07-2024.
- Kürschner H, Frey W** (2012) Life strategies in bryophytes—a prime example for the Evolution of functional types. *Nova Hedwigia* 96: 83–116.
- Lima E, Oliveira-da-Silva FR, Ilkiu-Borges AL** (2018) Flora das cangas da Serra dos Carajás, Pará, Brasil: Frullaniaceae. *Rodriguésia* 69: 973–981.
- Lisboa RCL, Ilkiu-Borges AL** (1997) A família Splachnobryaceae (Bryophyta) no estado do Pará. *Boletim Museu Paraense Emílio Goeldi, Série Botânica* 13: 103–111.
- Luizi-Ponzo AP, Bastos CJP, Costa DP, Porto KC, Câmara PEAS, Lisboa RCL, Boas-Bastos SV** (2006) Glossarium polyglotum bryologiae: Versão Brasileira do Glossário Briológico. Editora da Universidade Federal de Juiz de Fora, Juiz de Fora, Brazil, 11–114.
- Macedo LPC, Borges ALI** (2014) Richness of Marchantiophyta and Bryophyta in a protected area of the Brazilian Amazon. *Acta Botanica Brasilica* 28: 527–538. <https://doi.org/10.1590/0102-33062014abb3416>
- Mägdefrau K** (1982) Life-forms of bryophytes. In: *Bryophyte ecology*. Springer Netherlands, Dordrecht, Netherlands, 45–58.
- Novais TG** (2016) Condições climáticas em três cidades do clima tropical semiúmido: estudos preliminares de uma nova classificação climática. In: *Anais do XII Simpósio Brasileiro de Climatologia Geográfica*, Goiânia, Brazil, 2213–2225.
- NUGEO/UEMA** (2016) Bacias hidrográficas e climatologia no Maranhão. Núcleo geoambiental, Universidade Estadual do Maranhão, São Luis, Brazil. https://www.nugeo.uma.br/?page_id=255. Accessed on: 15-03-2022.
- Oliveira RF, Silva GS, Oliveira RR, Oliveira HC, Conceição GM** (2018a) Musgos (Bryophyta) de um fragmento do cerrado maranhense, Brasil. *Biota Amazônia* 8: 12–18.
- Oliveira RR, Medeiros DL, Oliveira HC, Conceição GM** (2018d) Briófitas de área sob o domínio fitogeográfico do Cerrado e novas ocorrências para o Maranhão e região Nordeste do Brasil. *Iheringia. Série Botânica* 73: 191–195. <https://doi.org/10.21826/2446-8231201873211>
- Oliveira RR, Oliveira HC, Peralta DF, Conceição GM** (2018b) Acrocarpic mosses (Bryophyta) of Chapada das Mesas National Park, Maranhão, Brazil. *Check List* 14: 967–975. <https://doi.org/10.15560/14.6.967>
- Oliveira RR, Oliveira RF, Oliveira HC, Peralta DF, Conceição GM** (2020) Pleurocarpous and cladocarpous mosses (Bryophyta) of Parque Nacional da Chapada das Mesas, with newly recorded species from Maranhão and the northeast region of Brazil. *Check List* 16: 1733–1745. <https://doi.org/10.15560/16.6.1733>
- Oliveira RR, Sá NA, Conceição GM** (2018c) Hepáticas (Marchantiophyta) do estado do Maranhão, Brasil. *Biota Amazônia* 8: 19–23. <https://doi.org/10.18561/2179-5746/biotaamazonia.v8n2p19-23>
- Oliveira-da-Silva FR, Ilkiu-Borges AL** (2016a) Flora das cangas da Serra dos Carajás, Pará, Brasil: Bartramiaceae. *Rodriguésia* 67: 1125–1128. <https://doi.org/10.1590/2175-7860201667502>
- Oliveira-da-Silva FR, Ilkiu-Borges AL** (2016b) Flora das cangas da Serra dos Carajás, Pará, Brasil: Stereophyllaceae. *Rodriguésia* 67: 1137–1140.
- Oliveira-da-Silva FR, Ilkiu-Borges AL** (2017) Flora das cangas da Serra dos Carajás, Pará, Brasil: Bryaceae. *Rodriguésia* 68: 797–801.
- Oliveira-da-Silva FR, Ilkiu-Borges AL** (2018a) Flora das cangas da Serra dos Carajás, Pará, Brasil: Calymperaceae. *Rodriguésia* 69: 955–967.
- Oliveira-da-Silva FR, Ilkiu-Borges AL** (2018b) Flora das cangas da Serra dos Carajás, Pará, Brasil: Hypnaceae. *Rodriguésia* 69: 983–987.
- Oliveira-da-Silva FR, Ilkiu-Borges AL** (2018c) Flora das cangas da Serra dos Carajás, Pará, Brasil: Pylaisiadelphaceae. *Rodriguésia* 69: 1029–1034.
- Oliveira-da-Silva FR, Ilkiu-Borges, AL** (2018d) Flora das cangas da Serra dos Carajás, Pará, Brasil: Sematophyllaceae. *Rodriguésia* 69: 1035–1044.
- Oliveira-da-Silva FR, Macedo LPC, Ilkiu-Borges AL** (2021) A checklist of the bryophytes from Amapá State, Northern Brazil. *Hoehnea* 48: e782020. <https://doi.org/10.1590/2236-8906-78/2020>
- Passos MLV, Zambrzycki GC, Pereira RS** (2016) Balanço Hídrico e classificação climática para uma determinada região de Chapadinha-MA. *Revista Brasileira de Agricultura Irrigada* 10: 758–766.
- Peralta DF, Yano O** (2005) Briófitas de mata paludosa, município de Zacarias, noroeste do Estado de São Paulo, Brasil. *Acta Botanica Brasilica* 19: 963–977.
- Peralta DF, Brito ES, Varão LF, Conceição GM, Cunha IPR** (2011) Novas ocorrências e lista das briófitas do estado do Maranhão, Brasil. *Pesquisa em Foco* 19: 63–78.
- Pinheiro EML, Câmara PEAS** (2012) Musgos pleurocárpicos de Capões de Mata no Parque Nacional da Chapada dos Veadeiros, Goiás, Brasil. *Heringeriana* 6: 54–65.
- Pursell RA** (2007) Fissidentaceae. *Flora Neotropica, Monograph* 101: 1–278.
- Puttick MN, Morris JL, Williams TA, Cox CJ, Edwards D, Kenrick P, Pressel S, Wellman CH, Schneider H, Pisani D, Donoghue PCJ** (2018) The Interrelationships of Land Plants and the Nature of the Ancestral Embryophyte. *Current Biology* 28: 773–745. <https://doi.org/10.1016/j.cub.2018.01.063>
- Reese WD** (1993) Calymperaceae. *Flora Neotropica, Monograph* 58: 1–101.
- Reiner-Drehwald ME** (2000) Las Lejeuneaceae (Hepaticae) de Misiones, Argentina VI. *Lejeunea y Taxilejeunea*. *Tropical bryology* 19: 81–131.
- Renzaglia KS, Villarreal JC, Duff RJ, Goffinet B** (2009) New insights into morphology, anatomy, and systematics of hornworts. *Bryophyte Biology* 2: 139–171.

- Richards PW** (1984) The ecology of tropical forest bryophytes. In: Schuster RM (Ed.) New Manual of Bryology. Hattori Botanical Laboratory, Nichinan, Japan, 1233–1270.
- Robbins RG** (1952) Bryophyte ecology of a dune area in New Zealand. Vegetation. Acta Geobotanica 4: 1–31.
- Ruklani NS, Rubasinghe SC, Villarreal JC** (2016) Two new records of Sri Lankan hornworts, *Notothylas javanica* (Notothyladaceae) and *Megaceros flagellaris* (Dendrocerotaceae). Cryptogamie, Bryologie 37: 435–444.
- Santos FJL, Conceição GM** (2010) Espécies da Brioflora do Parque Estadual do Mirador, Maranhão, Brasil. Cadernos de Geociências 7: 136–139.
- Schuster RM** (1980) The Hepaticae and Anthocerotae of North America IV. Columbia University Press, New York, USA, 1334 pp.
- Shi XQ, Zhu RL** (2015) A revision of *Archilejeunea* s.str. (Lejeuneaceae, Marchantiophyta). Nova Hedwigia 100: 589–601.
- Silva ALG, Martins F, Santos R, Nunes JLS** (2008) Conservação da Reserva do Itamacaoca em Chapadinha/MA. In: Selbach JF, Leite JRSA (Eds.) Meio ambiente no Baixo Parnaíba: olhos no mundo pés na região. EDUFMA, São Luís, Brazil, 109–116.
- Silva AM, Conceição GMS, Oliveira RR** (2018a) Musgos Musgos (Bryophyta) do Morro do Alecrim, centro urbano de Caxias, Maranhão, Brasil. Revista Arquivos Científicos (IMMES) 1: 55–62.
- Silva FB, Santos JRN, Feitosa FECS, Silva IDC, Araújo MLSD, Guterres CE, Santos JS, Ribeiro CV, Bezerra DS, Neres RL** (2016) Evidências de mudanças climáticas na região de transição Amazônia-Cerrado no Estado do Maranhão. Revista Brasileira de Meteorologia 31: 330–336. <https://doi.org/10.1590/0102-778631320150149>
- Silva JAS, Fernandes RS, Costa DP** (2018b) Species diversity of the genus *Riccia* L. (Marchantiales, Ricciaceae) in Maranhão state, Brazil. Check List 14: 763–769. <https://doi.org/10.15560/14.5.763>
- Silva JB, Sfair JC, Santos NDD, Pôrto KC** (2018c) Bryophyte richness of soil islands on rocky outcrops is not driven by island size or habitat heterogeneity. Acta Botanica Brasilica 32: 161–168.
- Silva JP, Oliveira-da-Silva FR, Ilkiu-Borges AL, Fernandes RS** (2021) Leafy liverworts of Chapada das Mesas National Park: a floristic survey and checklist of the leafy liverworts of Maranhão state, Brazil. Check List 17: 479–495. <https://doi.org/10.15560/17.1.479>
- Sukkharak P, Gradstein SR** (2017) Phylogenetic study of *Mastigolejeunea* (Marchantiophyta: Lejeuneaceae) and an amended circumscription of the genus *Thysananthus*. Phytotaxa 326: 91–107.
- Thiers B** (2022) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>. Accessed on: 13-08-2024.
- Tropicos.org.** (2024) Missouri Botanical Garden. Missouri Botanical Garden, Saint Louis, USA. <https://www.tropicos.org>. Accessed on: 27-01-2024.
- Varão LF, Cunha PR, Peralta DF** (2011) Levantamento de briófitas do distrito Bananal, município de Governador Edison Lobão, Maranhão, Brasil. Revista de Biologia e Ciências da Terra 11: 88–92.
- Vieira HCA, Oliveira RR, Silva MLA, Santos Silva DL, Conceição GM, Oliveira HC** (2017) Briófitas de ocorrências em São João do Sóter, Maranhão, Brasil. Acta Brasiliensis 1: 8–12.
- Yano O** (1992) Novas localidades de musgos nos estados do Brasil. Acta Amazônica 22: 197–218.
- Yano O** (2004) Novas ocorrências de briófitas para vários estados do Brasil. Acta Amazonica 34: 559–576.
- Yano O, Bordin J, Peralta DF** (2009) Briófitas dos estados do Ceará, Maranhão, Paraíba, Piauí e Rio Grande do Norte (Brasil). Hoehnea 36: 387–415.
- Yano O, Marinho M, Graças V, Mari G** (1987) Novas ocorrências de Briófitas no Nordeste Brasileiro. Rickia 14: 73–87.